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The Effect of Altitude Conditions on the Particle Emissions of a J85–GE–5L Turbojet Engine

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National Aeronautics and
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SUMMARY

Particles from the exhaust of a General Electric J85-5L turbojet engine using JP-5 fuel were measured over a range of engine speeds at simulated altitude conditions from near sea level to 45 000 ft and at flight Mach numbers of 0.5 and 0.8. Samples were collected from the engine by using a specially designed probe positioned several inches behind the exhaust nozzle. A differential mobility particle sizing system was used to determine particle size. Particle data measured at approximate sea-level conditions (5000 ft, Mach 0.5) were compared with Navy Aircraft Environmental Support Office (AESO) particle data taken from a GE-J85-4A engine at a sea-level, static condition.

The total number of particles was found to increase as the altitude of the engine decreased, and for a given altitude, the total number count stayed essentially constant as the engine speed was varied from 95 to 100 percent. Also, the total volume of the particles and their total surface area dramatically increased as the engine altitude decreased from 45 000 to 5000 ft. Thus, the Sauter mean diameter (SMD) increased as the altitude decreased from 45 000 to 5000 ft.

The NASA particle data measured at the simulated near sea-level condition (5000 ft, Mach 0.5) at 97.5-percent engine speed were compared with AESO particle data at a sea-level, static, military-power condition. Although the engine conditions were not identical, they were close enough for a valid comparison. The particle data were of the same order of magnitude in total number, and the number, surface area, and volume distributions were similar.

Comparisons were also made between particle data from the J85-5 engine and data from a J85 combustor rig. The rig's combustor inlet conditions were matched to the engine combustor conditions at simulated altitudes of 36 000 to 45 000 ft at Mach 0.8 over a range of engine speeds from 95 to 100 percent. The number of particles from the engine was generally higher in magnitude than the number of particles from the combustor rig. However, the total surface area and total volume of the particles from the combustor were generally higher than those of the particles from the engine. The SMD's of the combustor particles, which ranged from 0.055 to 0.075 μm, were higher than those of the engine particles (approximately 0.04 μm). The larger SMD's indicate that the characteristic diameter of the aerosol from the combustor is much larger than that from the engine.

INTRODUCTION

The environmental impact of turbojet emissions from high altitude aircraft is a critical concern. One pollutant of concern is the carbon particles, or soot, formed from the combustion process in jet engines. Soot particles have a long life in the atmosphere and are strongly absorbing at visible and infrared wavelengths. They also provide a large surface area on which atmospheric chemical reactions may occur. Furthermore, a small percentage of these particles may act as cloud condensation nuclei (ref. 1), causing contrails (cloud formations) that may affect the climate, and thus, the environment (ref. 2).

The overall intent of the work presented herein was to study the effect of altitude conditions on the size and distribution of particles emitted from a GE-J85-5L turbojet engine.

APPARATUS

Engine

The J85-GE-5L engine, shown in figure 1, is an afterburning turbojet engine comprising an eight-stage, axial-flow compressor coupled to a two-stage turbine. The engine incorporates a throughflow, annular-type combustion system and an afterburner with a variable exhaust nozzle. The engine has a rated sea-level static thrust of 2680 lbf at military power and 3850 lbf at maximum afterburning. The compressor has an overall total pressure ratio of 6.9 and a rated airflow of 44 lbm/s at a rated rotor speed of 16 542 rpm.

The fuel used for this test was JP-5, which complies with U.S. military specification MIL-T-5642H.

Test Facility

The test program was conducted in the Propulsion Systems Laboratory (PSL) at the NASA Lewis Research Center (see figs. 2 and 3). This altitude-simulation facility has two altitude chambers where full-scale gas turbine engines can be tested continuously at simulated altitudes to 80 000 ft and simulated Mach numbers to 3. Air handling equipment is sufficient to supply airflows to 480 lbm/s, pressures to 165 psia, and temperatures between -50 and +1200 °F (ref. 3).

The GE-J85-5L engine was instrumented to record and monitor its operating parameters. These measurements were recorded by the PSL's ESCORT data acquisition system.

Probe and Sampling System

Exhaust from the GE-J85-5L gas turbine engine was extracted by using a rake specially designed to minimize particle losses. The uncooled, stainless-steel probe (fig. 4) was located several inches behind the exit plane of the nozzle. It had nine ports that were spaced on centers of equal areas in order to collect a representative sample. The probe was also designed to sample isokinetically, which means that the sample in the probe tips had the same velocity as that of the free stream. Isokinetic sampling is important for accurate measurement of the larger particles (i.e., those close to 1 μm in diam), since the smaller particles have little inertia and can follow the streamlines better than the larger particles. The probe sample lines were designed to minimize particle losses from static charge buildup, Brownian diffusion, gravitational settling, and inertial deposition. For example, to prevent electrostatic deposition, grounded stainless-steel sample lines were utilized; to prevent particle losses due to diffusion, settling, and deposition, the sample-line length was minimized, vertical lines were used wherever feasible, and large-radius bends were employed; and to ensure that the temperature was not allowed to drop below 150 °F (before dilution), the sample-line temperature was monitored in order to prevent condensation of the water vapor, which would compromise the integrity of the sample.

The typical exhaust from the J85-5 engine at 45 000 ft is at Mach 1, 1270 °F, and a static pressure of 4.1 psia. The sampling system's main function was to condition the sample to atmospheric conditions and dilute the sample by a known amount, thereby accommodating a requirement of the particle analyzing system. (The particle analyzing system is shown in figs. 5 and 6.) This was accomplished with a special venturi-type vacuum pump that ejected filtered, compressed air through a convergent-divergent nozzle and, thus, induced the low-pressure sample to flow. The pump also diluted and cooled the sample to standard atmospheric conditions, as required by the analyzer system. The dilution and sample flowrates were measured by mass flowmeters in order to calculate the dilution ratio.

Particle Analyzer

A TSI differential mobility particle sizer (DMPS) was used to analyze the exhaust particles (see figs. 7 and 8). This analyzer is capable of continuous sampling and analysis of aerosol particles in the range of 0.01 to 1 μm. However, for this test the analyzer range was 0.01 to 0.457 μm, because the analyzer cannot sample the entire 0.01- to 1-μm range at the same time. The DMPS instrument measures the size distribution of aerosol over 32 size channels in approximately 30 minutes. It can measure particle concentrations as high as 10 million particles/cm^3 and as low as 0.01 particle/cm^3. With this analyzer there is the option of skipping every other channel; the software then interpolates the particle data for the skipped channels. By using this mode for the test, the sampling time was reduced to 15 minutes. To determine if this mode was sufficiently accurate, particle data taken with all 32 size channels were compared with particle data taken with 16 channels (the other 16 channels were interpolated by the software). This comparison showed that the data taken with 16 channels were sufficiently accurate.

ANALYTICAL PROCEDURE

Before each run, the particle analyzer system was cleaned and all the required flows were adjusted. The sample flow at the classifier inlet was checked for accuracy with an external mass flowmeter. The number of particles in the dilution air system was measured before every test run to ensure that the air was sufficiently particle free. In addition, background particle measurements of the air supplied to the engine were made before each test run while the engine was windmilling (no combustion). This measurement was made to ensure that the total particle count in the inlet air was sufficiently small in comparison to the engine research particle data (with combustion). In cases where the number of background particles was not sufficiently small, the analyzer software could store the background particle data and subtract these data from the research data. It may be important to consider the background particle data when calculating area, volume, and Sauter mean diameter (SMD).

The dilution ratio was determined for each data point by measuring the dilution air and the sample air with mass flowmeters. To determine the total particle count of the sample, the following equations were used:

$$\text{Dilution ratio} = \frac{\text{dilution flow}}{\text{sample flow}}$$

$$\text{Total count} = \text{measured count} \times (\text{dilution ratio} + 1)$$

The calculation for total particle count assumes that the dilution flow has a negligible particle count.

The DMPS system software package was used to process the particle data. The software package statistically determines the number, surface area, and volume of the particles as a function of diameter. In addition, it calculates the geometric standard deviation for the number, surface area, and volume distribution of the particles. See the appendix for a typical data output.

To calculate the SMD, the following formula was used:

$$\textit{Sauter mean diameter} = \frac{\sum nD^3}{\sum nD^2}$$

where n is the total particle concentration in particles per cubic centimeter and D is the particle diameter in micrometers.

TEST CONDITIONS

The engine test conditions are presented in table I. Facility limitations prohibit the operation of the engine with the altitude chamber at atmospheric pressure; thus true sea-level readings were not obtained. The lowest simulated altitude obtained was approximately 5000 ft. At each of the simulated altitudes (except 5000 ft), the engine was operated at 95-, 97.5-, and 100-percent speeds at simulated Mach 0.8. At the 5000-ft altitude, the engine was operated at 95- and 97.5-percent speeds at simulated Mach 0.5.

RESULTS AND DISCUSSION

Effect of Altitude on Total Particle Count

Figure 9 shows the results of the total particle counts for all the test conditions in table I. For a given altitude, the total particle count remained essentially constant as the engine speed was varied from 95 to 100 percent. However, between 45 000 and 5000 ft the total particle count increased by a factor of eight. This may be partially due to the large increase in combustor inlet pressure at the 5000-ft condition. The combustor inlet pressure at 5000 ft was approximately 80 psia, compared to 20 psia at 45 000 ft. Thus, at the 5000-ft altitude, the combustor inlet pressure was 60 psia higher. It is well known that increased pressure results in increased soot reaction rates, thus causing more carbon particle formation in the primary zone of the combustor (ref. 4). A secondary effect of pressure on soot formation is caused by the reduced penetration of the fuel spray at higher pressures. At low pressures, the fuel is distributed across the entire combustion zone, whereas at higher pressures the fuel tends to concentrate near the fuel nozzle, in the soot-forming region.

Combustor inlet temperature is another variable that is known to increase the soot-formation rate (ref. 5). Although the combustor inlet temperature at 5000 ft was 80 °F higher than at 45 000 ft, this effect may have been offset by the resulting increased combustor exit temperature, which caused the particles to burn up.

Effect of Altitude on Particle Number Distribution

In figures 10 and 11, particle number distribution on a percentage basis was plotted for the 95- and 97.5-percent engine speeds at the following altitude conditions: Mach 0.5 at 5000 ft, and Mach 0.8 at 36 000, 41 000, and 45 000 ft. These figures show that in altitudes ranging from 36 000 to 45 000 ft, the number distribution is very similar. However, at the 5000-ft altitude condition, the particle number distribution distinctly shifts to the right, indicating an increase in mean particle size at the lower altitudes.

Effect of Altitude on Total Surface Area

In figure 12, the total surface area of the particles at 95-percent engine power was plotted for the following altitude conditions: Mach 0.5 at 5000 ft, and Mach 0.8 at 36 000, 41 000, and 45 000 ft. This figure indicates that the total surface area of the particles increases with decreasing altitude. At 5000 ft, the total surface area shows a dramatic increase in comparison with the higher altitude data.

Effect of Altitude on Total Particle Volume

See figure 13 for the particle volume distribution at 95-percent engine speed for the following altitude conditions: Mach 0.5 at 5000 ft, and Mach 0.8 at 36 000, 41 000 ft, and 45 000 ft. This figure indicates that the total volume of the particles increases as the altitude decreases, with a dramatic increase in total volume at 5000 ft.

Effect of Altitude on Sauter Mean Diameter

Figure 14 shows the SMD for the engine speeds and altitudes given in table I. The SMD is widely used to characterize aerosols; it is defined as the diameter of a particle that has the same volume-to-surface-area ratio as the entire aerosol. In figure 14 the SMD is essentially constant at altitudes ranging from 36 000 to 45 000 ft. The SMD at 5000 ft, however, is significantly greater than it is at the higher altitudes.

Comparison With Published Data

Figures 15 to 20 compare particle measurement data taken by NASA at the Mach 0.5, 5000-ft altitude condition, with sea-level, static condition particle data (ref. 6) from the Navy Aircraft Environmental Support Office (AESO). The AESO data were taken from a GE-J85-4A engine, using Jet-A fuel, that was run at several engine speeds, from idle to military, at a sea-level, static (Mach-0) condition.

Several differences in the engine test conditions need to be noted before these data are compared. First, the AESO data were taken with a GE-J85-4A engine, which is very similar to the J85-5 version used by NASA; the differences are minimal and should have no effect on the particle data. Second, the NASA test fuel was JP-5, which has soot-formation properties that are very similar to the Jet-A fuel used by AESO. Therefore, the particle data comparison should be valid. Third, the particle analyzer used by AESO was the TSI Electrical Aerosol Analyzer (EAA), which is capable of measuring particles in the 0.01- to 1-μm-size range in eight increments. Although the EAA uses the same operating principle as the DMPS, it sacrifices resolution for time. The DMPS system used by NASA was operated with 16 size channels (the other 16 channels were interpolated); it took 15 minutes to sample, whereas the EAA, with 8 size channels, took 2 minutes. The two analyzers have been shown by the manufacturer, TSI, to give comparable results in particle measurement.

Finally, figures 15 to 19 compare the particle data from the NASA J85-5 engine at an altitude of 5000 ft, a simulated Mach number of 0.5, and 97.5-percent engine speed with data from a J85-4 engine at sea level, a static condition, and 100-percent engine speed. Table II shows the combustor inlet conditions and the fuel-to-air ratios for the two engines tested. Although the combustor inlet conditions and fuel-to-air ratios differ, the particle number data should be of the same order of magnitude, and the size distribution should be similar.

Comparison of NASA and AESO Total-Particle-Count Data

Figure 15 compares NASA total-particle-count data taken at the 5000-ft, Mach-0.5 condition at 95- and 97.5-percent engine speeds with AESO total-particle-count data at a sea-level, static condition, at 48-, 85-, and 100-percent engine speeds. Although the AESO data encompassed a wider range of engine speeds than the NASA data, there is very good agreement in total particle count (i.e., same order of magnitude).

Modification of NASA Data

In order to compare the NASA particle data with the AESO data, the NASA data were modified by regrouping the 32 channels of data into 8 channels. Figure 16 shows both the original NASA data with 32 channels and the same NASA data grouped into 8 channels. This alteration was done for the data shown in figures 17 to 19.

Comparison of NASA and AESO Number Concentration Data

Figure 17 shows the comparison of particle percent of total number concentration (number of particles as a percentage of total particle concentration) as a function of diameter. The modified NASA particle data were taken at the 5000-ft, Mach 0.5 condition at 97.5-percent engine speed, and the AESO data were taken at a sea-level, static condition at military power (see table II for a comparison of combustor conditions). The intent of this figure is to show that the number distribution of the particles is similar and that most of the particles are in the 0.01- to 0.1-μm size range.

Comparison of NASA and AESO Percent-of-Total-Surface-Area Data

Figure 18 shows the modified NASA data relating to the percent of total particle surface area at the 5000-ft, Mach-0.5, 97.5-percent engine speed condition compared with AESO data at the sea-level, static, 100-percent engine speed condition. This figure shows a good match in data.

Comparison of NASA and AESO Percent-of-Total-Volume Data

Figure 19 shows the modified NASA percent of total particle volume at the 5000-ft, Mach-0.5, 97.5-percent engine speed condition compared with AESO particle data taken at the sea-level, static, 100-percent engine speed condition. The data compare well.

Comparison of NASA and AESO Sauter Mean Diameter

The SMD variation with engine speed for both AESO and NASA data is shown in figure 20. The AESO data were taken at a sea-level, static condition at several speed settings. They are compared with NASA data taken at the 5000-ft, Mach-0.5 condition at 95- and 97.5-percent engine speeds. The AESO data cover a wider range of engine speeds (from idle to 100 percent) than do the NASA data; however, the NASA SMD data match very well with the AESO SMD data. It is interesting to note that the SMD does not change as the engine speed increases from idle to 85 percent, even though the combustor inlet pressure increases from 21 to 42 psia and the combustor inlet temperature increases from 140 to 295 °F. Both pressure and temperature are known to have a strong effect on carbon formation in the combustor, yet figure 15 shows the total particle count decreases slightly as engine speed increases from idle to 85 percent. If more carbon were being formed, one would expect to see an increase in particle number count or a big change in SMD, indicating that the carbon particles were getting bigger while the number stayed the same. What most likely happens as the engine speed increases is that more carbon is formed as a result of the increase in combustor inlet temperature and pressure; however this is offset by the increase in combustor exit temperature, which burns up the carbon particles. In other words, between idle and 85-percent speed, the carbon formation rate is equivalent to the carbon consumption rate.

In figure 20 the SMD increases rapidly as the engine speed increases from 85 to 100 percent. In this range, the combustor inlet pressure increases from 42 to 90 psia and the inlet temperature increases from 295 to 506 °F. Also, the fuel flow dramatically increases between 95- and 100-percent speed, contributing to the increase in carbon formation. Because of the increase in combustor inlet temperature and pressure, along with the big increase in fuel-to-air ratio, carbon formation should increase dramatically. However, carbon formation would be partially offset by the big increase in combustor exit temperature, which would burn up or oxidize the particles. Figure 15 shows the total number count remains essentially constant between 85- and 100-percent speed, yet the SMD increases by 50 percent. Thus, the carbon mass must have increased since the SMD has increased dramatically.

Comparison of Engine and Combustor Rig Data

The J85 engine particle data were compared with J85 combustor rig particle data in order to determine if the turbine had any impact on the particle data (unpublished work, James S. Fear and June E. Rickey, NASA Lewis Research Center, 1992). The combustor inlet conditions in the rig were matched to the combustor inlet conditions of the engine at simulated altitudes from 36 000 to 45 000 ft at a Mach number of 0.8 over a range of engine speeds from 95 to 100 percent.

Comparison of Engine and Combustor Total Particle Number Count

Figure 21 shows the comparison of total particle count versus percent engine speed for simulated altitudes of 36 000, 41 000, and 45 000 ft. The data for the engine and combustor compare reasonably well and are of the same order of magnitude.

Comparison of Engine and Combustor Total Particle Surface Area

In figure 22 the total particle surface area versus percent engine speed is compared for the engine and the combustor. The total surface area was generally lower in magnitude for the engine than for the combustor. At the 100-percent engine speed condition for each altitude, the combustor and engine data match very well. These data diverge, however, as the speed is lowered from 100 to 95 percent.

Comparison of Engine and Combustor Total Particle Volume

The comparison of total particle volume versus percent engine speed for the engine and combustor is shown in figure 23. The total particle volume from the engine was lower in magnitude than that from the combustor. At 100-percent engine speed, the combustor and engine data match quite well except at 36 000 ft, where there is a great disparity between these data.

Comparison of Engine and Combustor Sauter Mean Diameter

Figure 24 shows the comparison of SMD versus percent engine speed for the engine and the combustor. The SMD for the engine over the range of altitude conditions is essentially constant at 0.04 μm. The SMD for the combustor varies from 0.05 to 0.078 μm, increasing in magnitude as altitude is decreased. Thus there are bigger particles formed in the combustor than in the engine.

CONCLUDING REMARKS

The effects of altitude on total particle number concentration, number distribution, surface area, volume, and Sauter mean diameter (SMD) have been examined. It is apparent that engine particle data taken at a sea-level, static test condition do not adequately represent engine particle data at the higher altitudes. At the altitudes near sea level, the particles were found to greatly increase in size.

Comparisons were made of particle data from the J85-5 engine and particle data from a J85 combustor mounted in a rig. The J85 combustor inlet conditions were matched to the engine combustor inlet conditions at several altitudes over a range of engine speeds. For a given altitude and engine speed, the combustor emitted fewer and larger particles than the engine. It was not possible to determine whether the turbine in the engine test had an effect on the particle data.

Although trends of data taken from different combustion systems and at various flight conditions may be very meaningful, it is likely that the determination of absolute values of particle data will require testing with the combustion system of interest at the flight conditions of interest.

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER
6/26/92 5K M 0.5 D/S = 175.4/17.3 N = 95

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL
MAXIMUM DIA. MEASURED: .457 UM START: 21:44:48
DATE: 06-26-1992 MINIMUM DIA. MEASURED: .011 UM END: 21:54:23
FILE NAME : B:\DATA\JUN26 RECORD: # 11

DIA CH#	DIAMETER MIDPOINT (UM)	CONCENTRATION NUMBER (#/CC)	CONCENTRATION SURFACE (UM^2/CC)	CONCENTRATION VOLUME (UM^3/CC)	PERCENTAGE NUMBER CUMULATIVE	PERCENTAGE SURFACE CUMULATIVE	PERCENTAGE VOLUME CUMULATIVE
1	0	0	0	0	0	0	0
2	.012	3.06E 4	14.817	3.06E-2	1.406	.115	2.26E-2
3	.014	5.36E 4	34.59	8.26E-2	3.867	.385	8.36E-2
4	.017	8.83E 4	76.005	.21	7.922	.977	.239
5	.019	1.29E 5	147.935	.471	13.841	2.13	.587
6	.022	1.61E 5	247.249	.909	21.259	4.057	1.259
7	.025	1.98E 5	405.178	1.721	30.374	7.215	2.53
8	.029	2.62E 5	715.179	3.508	42.441	12.788	5.122
9	.034	2.77E 5	1007.808	5.708	55.191	20.642	9.339
10	.039	2.57E 5	1246.576	8.153	67.018	30.357	15.363
11	.045	2.33E 5	1508.564	11.394	77.751	42.113	23.781
12	.052	1.8 E 5	1548.414	13.505	86.012	54.18	33.759
13	.06	1.11E 5	1275.263	12.844	91.114	64.119	43.248
14	.07	8.08E 4	1236.426	14.38	94.824	73.754	53.873
15	.081	5.41E 4	1103.947	14.827	97.308	82.358	64.828
16	.093	2.96E 4	807.442	12.523	98.67	88.65	74.08
17	.107	1.59E 4	579.993	10.388	99.404	93.17	81.755
18	.124	7392.555	357.638	7.397	99.743	95.957	87.22
19	.143	3282.95	211.794	5.058	99.894	97.608	90.957
20	.165	1322.828	113.803	3.139	99.954	98.495	93.276
21	.191	446.123	51.18	1.63	99.975	98.894	94.481
22	.221	224.214	34.301	1.262	99.985	99.161	95.413
23	.255	100.024	20.406	.867	99.99	99.32	96.053
24	.294	81.799	22.253	1.091	99.994	99.493	96.86
25	.34	62.663	22.733	1.288	99.996	99.671	97.811
26	.392	46.98	22.728	1.486	99.999	99.848	98.909
27	.453	30.3	19.547	1.476	100	100	100
28	.523	0	0	0	0	0	0
29	.604	0	0	0	0	0	0
30	.698	0	0	0	0	0	0
31	.806	0	0	0	0	0	0
32	.931	0	0	0	0	0	0
TOTALS:		2.17E 6	1.28E 4	135.347			
FOR MEASURED DATA ONLY							
GEO. MEAN:		3.45E-2	5.5 E-2	7.38E-2			
SPREAD FACTOR:		1.588	1.665	1.796			

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER

6/26/92 5K M 0.5 D/S = 175.4/17.3 N = 95

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL

MAXIMUM DIA. MEASURED: .457 UM START: 21:44:48

DATE: 06-26-1992 MINIMUM DIA. MEASURED: .011 UM END: 21:54:23

FILE NAME : B:\DATA\JUN26 RECORD: # 11

MOBILITY CHANNEL#	MOBILITY MIDPOINT (CM^2/(VS))	DIAMETER MIDPOINT (UM)	CPC CONCENTRATION (PART/CC)	NUMBER CONCENTRATION (PART/CC)
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2	1.69E-2	.011	222.992	1.14E 4
3	1.39E-2	.012	474.324	2.09E 4
4	1.13E-2	.014	725.655	2.77E 4
5	9.30E-3	.015	1427.328	4.83E 4
6	7.61E-3	.017	2129	6.43E 4
7	6.23E-3	.018	3232.5	8.66E 4
8	5.09E-3	.021	4336	1.03E 5
9	4.17E-3	.023	5728	1.22E 5
10	3.41E-3	.025	7120	1.37E 5
11	2.79E-3	.028	1.00E 4	1.76E 5
12	2.28E-3	.031	1.30E 4	2.08E 5
13	1.86E-3	.035	1.39E 4	1.99E 5
14	1.52E-3	.038	1.47E 4	1.97E 5
15	1.25E-3	.043	1.45E 4	1.81E 5
16	1.02E-3	.048	1.43E 4	1.67E 5
17	8.37E-4	.053	1.15E 4	1.26E 5
18	6.85E-4	.059	8737	9.05E 4
19	5.60E-4	.066	7151	7.10E 4
20	4.58E-4	.074	5565	5.34E 4
21	3.75E-4	.083	4060.5	3.79E 4
22	3.07E-4	.093	2556	2.33E 4
23	2.51E-4	.104	1698.307	1.54E 4
24	2.05E-4	.117	840.615	7531.1
25	1.68E-4	.132	512.799	4624.22
26	1.37E-4	.15	184.983	1645.15
27	1.12E-4	.17	110.387	997.02
28	9.21E-5	.193	35.792	310.32
29	7.53E-5	.221	23.492	209.79
30	6.16E-5	.253	11.191	97.29
31	5.04E-5	.291	8.333	82.97
32	4.12E-5	.337	5.474	64.4
33	3.37E-5	.391	3.947	49.87
34	2.76E-5	.457	2.42	32.99
35	2.26E-5	.535	0	0
36	1.85E-5	.631	0	0
37	1.51E-5	.746	0	0
38	1.23E-5	.886	0	0
39	1.01E-5	1.056	0	0
		TOTALS:	1.49E 5	2.18E 6

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER
6/26/92 5K M 0.5 D/S = 174.94/17.41 N = 97.5

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL
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DATE: 06-26-1992 MINIMUM DIA. MEASURED: .011 UM END: 22:26:59
FILE NAME : B:\DATA\JUN26 RECORD: # 13

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1	0	0	0	0	0	0	0
2	.012	1.65E 4	8.012	1.65E-2	.523	3.22E-2	5.64E-3
3	.014	3.61E 4	23.311	5.56E-2	1.665	.126	2.46E-2
4	.017	6.91E 4	59.506	.164	3.851	.365	8.05E-2
5	.019	1.18E 5	135.64	.432	7.588	.911	.228
6	.022	1.65E 5	253.811	.933	12.831	1.931	.546
7	.025	2.27E 5	464.353	1.972	20.024	3.799	1.218
8	.029	3.26E 5	888.362	4.357	30.344	7.372	2.704
9	.034	3.71E 5	1349.346	7.642	42.099	12.798	5.309
10	.039	3.76E 5	1821.64	11.914	53.999	20.124	9.37
11	.045	3.62E 5	2339.08	17.666	65.457	29.531	15.393
12	.052	3.26E 5	2811.393	24.52	75.785	40.837	23.751
13	.06	2.71E 5	3117.371	31.397	84.373	53.374	34.454
14	.07	2.12E 5	3249.124	37.789	91.085	66.44	47.336
15	.081	1.43E 5	2925.137	39.287	95.616	78.204	60.729
16	.093	6.92E 4	1883.261	29.209	97.804	85.778	70.686
17	.107	3.74E 4	1358.055	24.323	98.987	91.239	78.978
18	.124	1.80E 4	872.787	18.051	99.557	94.749	85.131
19	.143	8137.552	524.981	12.538	99.814	96.861	89.405
20	.165	3342.266	287.535	7.93	99.92	98.017	92.109
21	.191	1129.769	129.61	4.128	99.955	98.538	93.516
22	.221	578.445	88.494	3.255	99.974	98.894	94.625
23	.255	270.7	55.225	2.346	99.982	99.116	95.425
24	.294	213.854	58.179	2.853	99.989	99.35	96.398
25	.34	155.287	56.336	3.191	99.994	99.577	97.485
26	.392	116.662	56.439	3.691	99.998	99.804	98.744
27	.453	75.632	48.793	3.685	100	100	100
28	.523	0	0	0	0	0	0
29	.604	0	0	0	0	0	0
30	.698	0	0	0	0	0	0
31	.806	0	0	0	0	0	0
32	.931	0	0	0	0	0	0
TOTALS:		3.16E 6	2.48E 4	293.346			
FOR MEASURED DATA ONLY							
GEO. MEAN:		4.03E-2	6.23E-2	8.13E-2			
SPREAD FACTOR:		1.586	1.622	1.746			

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER

6/26/92 5K M 0.5 D/S = 174.94/17.41 N = 97.5

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL

MAXIMUM DIA. MEASURED: .457 UM START: 22:17:48

DATE: 06-26-1992 MINIMUM DIA. MEASURED: .011 UM END: 22:26:59

FILE NAME : B:\DATA\JUN26 RECORD: # 13

MOBILITY CHANNEL#	MOBILITY MIDPOINT (CM^2/(VS))	DIAMETER MIDPOINT (UM)	CPC CONCENTRATION (PART/CC)	NUMBER CONCENTRATION (PART/CC)
1	2.07E-2	.01	0	0
2	1.69E-2	.011	85.747	4386.04
3	1.39E-2	.012	252.931	1.11E 4
4	1.13E-2	.014	420.115	1.60E 4
5	9.30E-3	.015	1040.557	3.51E 4
6	7.61E-3	.017	1661	5.00E 4
7	6.23E-3	.018	2902	7.74E 4
8	5.09E-3	.021	4143	9.82E 4
9	4.17E-3	.023	6117	1.30E 5
10	3.41E-3	.025	8091	1.55E 5
11	2.79E-3	.028	1.23E 4	2.15E 5
12	2.28E-3	.031	1.66E 4	2.63E 5
13	1.86E-3	.035	1.91E 4	2.72E 5
14	1.52E-3	.038	2.16E 4	2.84E 5
15	1.25E-3	.043	2.24E 4	2.74E 5
16	1.02E-3	.048	2.33E 4	2.66E 5
17	8.37E-4	.053	2.22E 4	2.39E 5
18	6.85E-4	.059	2.11E 4	2.18E 5
19	5.60E-4	.066	1.81E 4	1.81E 5
20	4.58E-4	.074	1.51E 4	1.46E 5
21	3.75E-4	.083	1.05E 4	9.85E 4
22	3.07E-4	.093	5859	5.34E 4
23	2.51E-4	.104	3954	3.58E 4
24	2.05E-4	.117	2049	1.83E 4
25	1.68E-4	.132	1258.479	1.13E 4
26	1.37E-4	.15	467.959	4157.5
27	1.12E-4	.17	279.396	2518.79
28	9.21E-5	.193	90.832	786.8
29	7.53E-5	.221	60.368	541.49
30	6.16E-5	.253	29.904	263.73
31	5.04E-5	.291	21.734	217.46
32	4.12E-5	.337	13.564	159.58
33	3.37E-5	.391	9.802	123.84
34	2.76E-5	.457	6.041	82.36
35	2.26E-5	.535	0	0
36	1.85E-5	.631	0	0
37	1.51E-5	.746	0	0
38	1.23E-5	.886	0	0
39	1.01E-5	1.056	0	0
		TOTALS:	2.41E 5	3.16E 6

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER

5/26/92 36K M 0.8 D/S = 176/17.6 N = 93

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL

MAXIMUM DIA. MEASURED: .457 UM START: 20:35:16

DATE: 05-26-1992 MINIMUM DIA. MEASURED: .011 UM END: 20:45:34

FILE NAME : B:\DATA\MAY26 RECORD: # 6

DIA	DIAMETER	CONCENTRATION			PERCENTAGE		
CH#	MIDPOINT (UM)	NUMBER (#/CC)	SURFACE (UM^2/CC)	VOLUME (UM^3/CC)	NUMBER	SURFACE	VOLUME
					CUMULATIVE PERCENTAGE		
1	0	0	0	0	0	0	0
2	.012	6.68E 4	32.345	6.69E-2	9.355	1.684	.461
3	.014	7.71E 4	49.793	.119	20.154	4.277	1.282
4	.017	8.83E 4	75.999	.21	32.515	8.235	2.727
5	.019	8.82E 4	101.273	.323	44.867	13.508	4.952
6	.022	8.50E 4	130.127	.479	56.768	20.284	8.252
7	.025	7.68E 4	156.803	.666	67.523	28.449	12.845
8	.029	6.57E 4	178.77	.877	76.717	37.758	18.892
9	.034	5.26E 4	191.064	1.082	84.086	47.707	26.355
10	.039	3.72E 4	180.271	1.179	89.3	57.094	34.487
11	.045	2.87E 4	185.66	1.402	93.327	66.762	44.157
12	.052	2.05E 4	176.938	1.543	96.205	75.976	54.8
13	.06	1.23E 4	141.176	1.422	97.926	83.327	64.607
14	.07	7488.755	114.567	1.332	98.974	89.293	73.796
15	.081	4137.756	84.414	1.134	99.553	93.688	81.615
16	.093	1791.072	48.726	.756	99.804	96.226	86.827
17	.107	844.797	30.648	.549	99.922	97.822	90.613
18	.124	317.881	15.378	.318	99.967	98.622	92.806
19	.143	130.621	8.427	.201	99.985	99.061	94.194
20	.165	49.226	4.235	.117	99.992	99.282	95
21	.191	20.777	2.384	7.59E-2	99.995	99.406	95.524
22	.221	12.652	1.936	7.11E-2	99.996	99.507	96.015
23	.255	6.865	1.4	5.94E-2	99.997	99.58	96.425
24	.294	5.42	1.474	7.23E-2	99.998	99.656	96.924
25	.34	4.474	1.623	9.19E-2	99.999	99.741	97.558
26	.392	4.418	2.137	.14	99.999	99.852	98.522
27	.453	4.399	2.838	.214	100	100	100
28	.523	0	0	0	0	0	0
29	.604	0	0	0	0	0	0
30	.698	0	0	0	0	0	0
31	.806	0	0	0	0	0	0
32	.931	0	0	0	0	0	0
TOTALS:		7.14E 5	1920.408	14.5			
FOR MEASURED DATA ONLY							
GEO. MEAN:		2.31E-2	3.83E-2	5.46E-2			
SPREAD FACTOR:		1.558	1.739	1.928			

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER
5/26/92 36K M 0.8 D/S = 176/17.6 N = 93

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL
MAXIMUM DIA. MEASURED: .457 UM START: 20:35:16
DATE: 05-26-1992 MINIMUM DIA. MEASURED: .011 UM END: 20:45:34
FILE NAME : B:\DATA\MAY26 RECORD: # 6

MOBILITY CHANNEL#	MOBILITY MIDPOINT (CM^2/(VS))	DIAMETER MIDPOINT (UM)	CPC CONCENTRATION (PART/CC)	NUMBER CONCENTRATION (PART/CC)
1	2.07E-2	.01	0	0
2	1.69E-2	.011	797.004	4.07E 4
3	1.39E-2	.012	1068.002	4.72E 4
4	1.13E-2	.014	1339	5.13E 4
5	9.30E-3	.015	1724.5	5.86E 4
6	7.61E-3	.017	2110	6.40E 4
7	6.23E-3	.018	2362.5	6.37E 4
8	5.09E-3	.021	2615	6.30E 4
9	4.17E-3	.023	2754.5	5.99E 4
10	3.41E-3	.025	2894	5.70E 4
11	2.79E-3	.028	2838.5	5.05E 4
12	2.28E-3	.031	2783	4.49E 4
13	1.86E-3	.035	2481.5	3.61E 4
14	1.52E-3	.038	2180	2.93E 4
15	1.25E-3	.043	1905	2.38E 4
16	1.02E-3	.048	1630	1.92E 4
17	8.37E-4	.053	1300.747	1.44E 4
18	6.85E-4	.059	971.494	1.02E 4
19	5.60E-4	.066	707.302	7166.16
20	4.58E-4	.074	443.11	4317.79
21	3.75E-4	.083	295.473	2804.63
22	3.07E-4	.093	147.836	1365.97
23	2.51E-4	.104	92.198	843.56
24	2.05E-4	.117	36.56	327.63
25	1.68E-4	.132	21.721	194.32
26	1.37E-4	.15	6.881	58.83
27	1.12E-4	.17	4.404	37.91
28	9.21E-5	.193	1.927	15.77
29	7.53E-5	.221	1.39	11.88
30	6.16E-5	.253	.852	6.69
31	5.04E-5	.291	.619	5.48
32	4.12E-5	.337	.387	4.55
33	3.37E-5	.391	.371	4.69
34	2.76E-5	.457	.355	4.84
35	2.26E-5	.535	0	0
36	1.85E-5	.631	0	0
37	1.51E-5	.746	0	0
38	1.23E-5	.886	0	0
39	1.01E-5	1.056	0	0
		TOTALS:	3.55E 4	7.51E 5

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER
5/26/92 36K M 0.8 D/S = 176/17.6 N = 95

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL
MAXIMUM DIA. MEASURED: .457 UM START: 20:48:04
DATE: 05-26-1992 MINIMUM DIA. MEASURED: .011 UM END: 20:58:23
FILE NAME : B:\DATA\MAY26 RECORD: # 7

DIA CH#	DIAMETER MIDPOINT (UM)	CONCENTRATION NUMBER (#/CC)	CONCENTRATION SURFACE (UM^2/CC)	CONCENTRATION VOLUME (UM^3/CC)	PERCENTAGE NUMBER CUMULATIVE	PERCENTAGE SURFACE CUMULATIVE	PERCENTAGE VOLUME CUMULATIVE
1	0	0	0	0	0	0	0
2	.012	6.63E 4	32.09	6.63E-2	9.664	1.793	.503
3	.014	7.55E 4	48.751	.116	20.673	4.518	1.386
4	.017	8.47E 4	72.937	.201	33.024	8.594	2.911
5	.019	8.39E 4	96.361	.307	45.261	13.979	5.238
6	.022	8.14E 4	124.669	.459	57.133	20.946	8.715
7	.025	7.48E 4	152.664	.648	68.036	29.478	13.631
8	.029	6.34E 4	172.547	.846	77.276	39.121	20.048
9	.034	5.13E 4	186.259	1.055	84.756	49.53	28.046
10	.039	3.69E 4	178.769	1.169	90.139	59.521	36.911
11	.045	2.63E 4	170.272	1.286	93.984	69.037	46.662
12	.052	1.80E 4	155.063	1.352	96.61	77.702	56.916
13	.06	1.06E 4	122.33	1.232	98.164	84.539	66.258
14	.07	6334.625	96.91	1.127	99.086	89.955	74.804
15	.081	3437.373	70.126	.942	99.587	93.874	81.945
16	.093	1521.535	41.393	.642	99.809	96.187	86.813
17	.107	755.102	27.394	.491	99.919	97.718	90.533
18	.124	314.612	15.22	.315	99.965	98.569	92.92
19	.143	130.25	8.403	.201	99.984	99.038	94.442
20	.165	49.634	4.27	.118	99.991	99.277	95.335
21	.191	21.292	2.443	7.78E-2	99.994	99.413	95.924
22	.221	13.976	2.138	7.86E-2	99.996	99.533	96.521
23	.255	9.798	1.999	8.49E-2	99.997	99.644	97.164
24	.294	7.647	2.08	.102	99.999	99.761	97.938
25	.34	5.151	1.869	.106	99.999	99.865	98.74
26	.392	3.288	1.591	.104	100	99.954	99.529
27	.453	1.274	.822	6.20E-2	100	100	100
28	.523	0	0	0	0	0	0
29	.604	0	0	0	0	0	0
30	.698	0	0	0	0	0	0
31	.806	0	0	0	0	0	0
32	.931	0	0	0	0	0	0
TOTALS:		6.86E 5	1789.372	13.189			
FOR MEASURED DATA ONLY							
GEO. MEAN:		2.29E-2	3.75E-2	5.31E-2			
SPREAD FACTOR:		1.549	1.732	1.9			

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER

5/26/92 36K M 0.8 D/S = 176/17.6 N = 95

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL

MAXIMUM DIA. MEASURED: .457 UM START: 20:48:04

DATE: 05-26-1992 MINIMUM DIA. MEASURED: .011 UM END: 20:58:23

FILE NAME : B:\DATA\MAY26 RECORD: # 7

MOBILITY CHANNEL#	MOBILITY MIDPOINT (CM^2/(VS))	DIAMETER MIDPOINT (UM)	CPC CONCENTRATION (PART/CC)	NUMBER CONCENTRATION (PART/CC)
1	2.07E-2	.01	0	0
2	1.69E-2	.011	795.145	4.06E 4
3	1.39E-2	.012	1060.073	4.68E 4
4	1.13E-2	.014	1325	5.07E 4
5	9.30E-3	.015	1673	5.68E 4
6	7.61E-3	.017	2021	6.13E 4
7	6.23E-3	.018	2251.5	6.07E 4
8	5.09E-3	.021	2482	5.98E 4
9	4.17E-3	.023	2653.5	5.77E 4
10	3.41E-3	.025	2825	5.56E 4
11	2.79E-3	.028	2749	4.89E 4
12	2.28E-3	.031	2673	4.32E 4
13	1.86E-3	.035	2427	3.54E 4
14	1.52E-3	.038	2181	2.94E 4
15	1.25E-3	.043	1806	2.27E 4
16	1.02E-3	.048	1431	1.68E 4
17	8.37E-4	.053	1137.255	1.26E 4
18	6.85E-4	.059	843.511	8917.05
19	5.60E-4	.066	605.602	6134.13
20	4.58E-4	.074	367.694	3573.81
21	3.75E-4	.083	247.007	2335.52
22	3.07E-4	.093	126.319	1162.28
23	2.51E-4	.104	81.272	741.33
24	2.05E-4	.117	36.226	323.96
25	1.68E-4	.132	21.596	192.68
26	1.37E-4	.15	6.966	59.36
27	1.12E-4	.17	4.479	38.21
28	9.21E-5	.193	1.993	16.26
29	7.53E-5	.221	1.51	13.12
30	6.16E-5	.253	1.026	9.55
31	5.04E-5	.291	.739	7.8
32	4.12E-5	.337	.452	5.32
33	3.37E-5	.391	.276	3.49
34	2.76E-5	.457	.1	1.36
35	2.26E-5	.535	0	0
36	1.85E-5	.631	0	0
37	1.51E-5	.746	0	0
38	1.23E-5	.886	0	0
39	1.01E-5	1.056	0	0
		TOTALS:	3.38E 4	7.23E 5

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER

5/26/92 36K M 0.8 D/S = 176/17.6 N = 97.3

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL

MAXIMUM DIA. MEASURED: .457 UM START: 21:32:03

DATE: 05-26-1992 MINIMUM DIA. MEASURED: .011 UM END: 21:42:29

FILE NAME : B:\DATA\MAY26 RECORD: # 9

DIA CH#	DIAMETER MIDPOINT (UM)	CONCENTRATION NUMBER (#/CC)	CONCENTRATION SURFACE (UM^2/CC)	CONCENTRATION VOLUME (UM^3/CC)	PERCENTAGE NUMBER CUMULATIVE	PERCENTAGE SURFACE CUMULATIVE	PERCENTAGE VOLUME CUMULATIVE
1	0	0	0	0	0	0	0
2	.012	6.92E 4	33.477	6.92E-2	9.067	1.75	.499
3	.014	8.31E 4	53.625	.128	19.959	4.553	1.422
4	.017	9.65E 4	83.077	.229	32.612	8.896	3.074
5	.019	9.97E 4	114.471	.365	45.687	14.88	5.702
6	.022	9.60E 4	146.974	.541	58.275	22.564	9.599
7	.025	8.41E 4	171.759	.729	69.307	31.543	14.858
8	.029	7.02E 4	191.05	.937	78.509	41.53	21.613
9	.034	5.58E 4	202.648	1.148	85.828	52.124	29.886
10	.039	3.92E 4	189.625	1.24	90.964	62.037	38.827
11	.045	2.77E 4	179.038	1.352	94.6	71.396	48.574
12	.052	1.86E 4	160.095	1.396	97.039	79.765	58.64
13	.06	1.06E 4	121.655	1.225	98.428	86.125	67.473
14	.07	6186.881	94.65	1.101	99.239	91.073	75.408
15	.081	3264.867	66.606	.895	99.667	94.555	81.857
16	.093	1372.686	37.344	.579	99.846	96.507	86.032
17	.107	664.511	24.107	.432	99.934	97.767	89.145
18	.124	268.812	13.005	.269	99.969	98.447	91.084
19	.143	113.72	7.336	.175	99.984	98.831	92.347
20	.165	46.933	4.038	.111	99.99	99.042	93.15
21	.191	23.963	2.749	8.75E-2	99.993	99.186	93.781
22	.221	16.004	2.448	9.00E-2	99.995	99.314	94.43
23	.255	10.36	2.114	8.97E-2	99.996	99.424	95.077
24	.294	9.123	2.482	.122	99.998	99.554	95.955
25	.34	7.842	2.845	.161	99.999	99.702	97.116
26	.392	6.095	2.949	.193	99.999	99.857	98.506
27	.453	4.252	2.743	.207	100	100	100
28	.523	0	0	0	0	0	0
29	.604	0	0	0	0	0	0
30	.698	0	0	0	0	0	0
31	.806	0	0	0	0	0	0
32	.931	0	0	0	0	0	0
TOTALS:		7.63E 5	1912.91	13.872			
FOR MEASURED DATA ONLY							
GEO. MEAN:		2.27E-2	3.65E-2	5.35E-2			
SPREAD FACTOR:		1.529	1.737	2.026			

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER

5/26/92 36K M 0.8 D/S = 176/17.6 N = 97.3

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL

MAXIMUM DIA. MEASURED: .457 UM START: 21:32:03

DATE: 05-26-1992 MINIMUM DIA. MEASURED: .011 UM END: 21:42:29

FILE NAME : B:\DATA\MAY26 RECORD: # 9

MOBILITY CHANNEL#	MOBILITY MIDPOINT (CM^2/(VS))	DIAMETER MIDPOINT (UM)	CPC CONCENTRATION (PART/CC)	NUMBER CONCENTRATION (PART/CC)
1	2.07E-2	.01	0	0
2	1.69E-2	.011	766.253	3.91E 4
3	1.39E-2	.012	1099.126	4.86E 4
4	1.13E-2	.014	1432	5.48E 4
5	9.30E-3	.015	1868.5	6.34E 4
6	7.61E-3	.017	2305	7.00E 4
7	6.23E-3	.018	2649.5	7.15E 4
8	5.09E-3	.021	2994	7.22E 4
9	4.17E-3	.023	3084	6.71E 4
10	3.41E-3	.025	3174	6.25E 4
11	2.79E-3	.028	3056.5	5.44E 4
12	2.28E-3	.031	2939	4.75E 4
13	1.86E-3	.035	2626.5	3.83E 4
14	1.52E-3	.038	2314	3.13E 4
15	1.25E-3	.043	1904	2.39E 4
16	1.02E-3	.048	1494	1.76E 4
17	8.37E-4	.053	1166.48	1.30E 4
18	6.85E-4	.059	838.96	8885.99
19	5.60E-4	.066	595.515	6046.63
20	4.58E-4	.074	352.07	3430.16
21	3.75E-4	.083	232.513	2203.02
22	3.07E-4	.093	112.955	1039.66
23	2.51E-4	.104	72.03	656.04
24	2.05E-4	.117	31.105	276.13
25	1.68E-4	.132	18.809	165.43
26	1.37E-4	.15	6.514	53.62
27	1.12E-4	.17	4.477	36.98
28	9.21E-5	.193	2.44	19.23
29	7.53E-5	.221	1.827	15.02
30	6.16E-5	.253	1.213	10.04
31	5.04E-5	.291	.949	9.2
32	4.12E-5	.337	.684	8.05
33	3.37E-5	.391	.512	6.47
34	2.76E-5	.457	.34	4.64
35	2.26E-5	.535	0	0
36	1.85E-5	.631	0	0
37	1.51E-5	.746	0	0
38	1.23E-5	.886	0	0
39	1.01E-5	1.056	0	0
		TOTALS:	3.71E 4	7.98E 5

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER

5/26/92 36K M 0.8 D/S = 176/17.6 N = 100

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL

MAXIMUM DIA. MEASURED: .457 UM START: 21:01:49

DATE: 05-26-1992 MINIMUM DIA. MEASURED: .011 UM END: 21:12:23

FILE NAME : B:\DATA\MAY26 RECORD: # 8

DIA CH#	DIAMETER MIDPOINT (UM)	CONCENTRATION NUMBER (#/CC)	CONCENTRATION SURFACE (UM^2/CC)	CONCENTRATION VOLUME (UM^3/CC)	PERCENTAGE NUMBER CUMULATIVE	PERCENTAGE SURFACE CUMULATIVE	PERCENTAGE VOLUME CUMULATIVE
1	0	0	0	0	0	0	0
2	.012	1.10E 5	53.439	.111	10.573	2.25	.705
3	.014	1.23E 5	79.555	.19	22.377	5.6	1.917
4	.017	1.34E 5	115.992	.32	35.283	10.485	3.957
5	.019	1.36E 5	156.521	.499	48.343	17.076	7.137
6	.022	1.31E 5	200.574	.738	60.893	25.522	11.842
7	.025	1.15E 5	235.114	.999	71.924	35.422	18.212
8	.029	9.34E 4	254.262	1.247	80.87	46.129	26.166
9	.034	7.25E 4	263.169	1.491	87.814	57.211	35.673
10	.039	4.93E 4	238.63	1.561	92.536	67.26	45.628
11	.045	3.32E 4	214.725	1.622	95.721	76.302	55.972
12	.052	2.13E 4	183.756	1.603	97.766	84.039	66.195
13	.06	1.16E 4	133.205	1.342	98.877	89.649	74.752
14	.07	6469.32	98.971	1.151	99.497	93.816	82.094
15	.081	3191.412	65.108	.874	99.802	96.558	87.672
16	.093	1196.774	32.558	.505	99.917	97.929	90.893
17	.107	527.156	19.124	.343	99.967	98.734	93.077
18	.124	179.264	8.672	.179	99.984	99.099	94.221
19	.143	73.761	4.759	.114	99.991	99.3	94.946
20	.165	29.952	2.577	7.10E-2	99.994	99.408	95.4
21	.191	16.925	1.942	6.18E-2	99.996	99.49	95.794
22	.221	12.42	1.9	6.98E-2	99.997	99.57	96.24
23	.255	9.183	1.873	7.95E-2	99.998	99.649	96.747
24	.294	7.713	2.098	.103	99.999	99.737	97.404
25	.34	6.118	2.219	.126	99.999	99.831	98.205
26	.392	4.531	2.192	.143	100	99.923	99.12
27	.453	2.832	1.827	.138	100	100	100
28	.523	0	0	0	0	0	0
29	.604	0	0	0	0	0	0
30	.698	0	0	0	0	0	0
31	.806	0	0	0	0	0	0
32	.931	0	0	0	0	0	0
TOTALS:		1.04E 6	2374.762	15.678			
FOR MEASURED DATA ONLY							
GEO. MEAN:		2.2 E-2	3.39E-2	4.73E-2			
SPREAD FACTOR:		1.51	1.684	1.916			

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER

5/26/92 36K M 0.8 D/S = 176/17.6 N = 100

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL

MAXIMUM DIA. MEASURED: .457 UM START: 21:01:49

DATE: 05-26-1992 MINIMUM DIA. MEASURED: .011 UM END: 21:12:23

FILE NAME : B:\DATA\MAY26 RECORD: # 8

MOBILITY CHANNEL#	MOBILITY MIDPOINT (CM^2/(VS))	DIAMETER MIDPOINT (UM)	CPC CONCENTRATION (PART/CC)	NUMBER CONCENTRATION (PART/CC)
1	2.07E-2	.01	0	0
2	1.69E-2	.011	1340	6.85E 4
3	1.39E-2	.012	1767	7.81E 4
4	1.13E-2	.014	2194	8.40E 4
5	9.30E-3	.015	2695.5	9.16E 4
6	7.61E-3	.017	3197	9.71E 4
7	6.23E-3	.018	3634	9.80E 4
8	5.09E-3	.021	4071	9.82E 4
9	4.17E-3	.023	4215.5	9.18E 4
10	3.41E-3	.025	4360	8.59E 4
11	2.79E-3	.028	4106.5	7.32E 4
12	2.28E-3	.031	3853	6.24E 4
13	1.86E-3	.035	3389	4.96E 4
14	1.52E-3	.038	2925	3.96E 4
15	1.25E-3	.043	2330	2.94E 4
16	1.02E-3	.048	1735	2.05E 4
17	8.37E-4	.053	1327.279	1.48E 4
18	6.85E-4	.059	919.557	9779.22
19	5.60E-4	.066	634.394	6473.96
20	4.58E-4	.074	349.231	3422.58
21	3.75E-4	.083	222.607	2123.65
22	3.07E-4	.093	95.984	889.01
23	2.51E-4	.104	58.426	534.34
24	2.05E-4	.117	20.869	184.9
25	1.68E-4	.132	12.528	109.42
26	1.37E-4	.15	4.187	33.42
27	1.12E-4	.17	2.993	23.87
28	9.21E-5	.193	1.8	13.93
29	7.53E-5	.221	1.416	11.67
30	6.16E-5	.253	1.033	8.92
31	5.04E-5	.291	.784	7.81
32	4.12E-5	.337	.535	6.29
33	3.37E-5	.391	.381	4.81
34	2.76E-5	.457	.226	3.08
35	2.26E-5	.535	0	0
36	1.85E-5	.631	0	0
37	1.51E-5	.746	0	0
38	1.23E-5	.886	0	0
39	1.01E-5	1.056	0	0
		TOTALS:	4.94E 4	1.10E 6

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER
5/21/92 41K M 0.8 D/S = 175/18.5 N = 95

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL
MAXIMUM DIA. MEASURED: .457 UM START: 20:46:23
DATE: 05-21-1992 MINIMUM DIA. MEASURED: .011 UM END: 20:56:30
FILE NAME : B:\DATA\MAY21 RECORD: # 6

DIA CH#	DIAMETER MIDPOINT (UM)	CONCENTRATION NUMBER (#/CC)	CONCENTRATION SURFACE (UM^2/CC)	CONCENTRATION VOLUME (UM^3/CC)	PERCENTAGE NUMBER CUMULATIVE	PERCENTAGE SURFACE CUMULATIVE	PERCENTAGE VOLUME CUMULATIVE
1	0	0	0	0	0	0	0
2	.012	4.53E 4	21.95	4.54E-2	9.957	1.976	.584
3	.014	5.39E 4	34.798	8.31E-2	21.793	5.109	1.653
4	.017	6.04E 4	52.036	.144	35.067	9.793	3.5
5	.019	5.64E 4	64.719	.206	47.446	15.619	6.152
6	.022	5.36E 4	82.016	.302	59.211	23.002	10.033
7	.025	4.97E 4	101.437	.431	70.122	32.134	15.576
8	.029	4.14E 4	112.624	.552	79.207	42.273	22.683
9	.034	3.22E 4	116.853	.662	86.275	52.792	31.198
10	.039	2.18E 4	105.803	.692	91.074	62.317	40.101
11	.045	1.64E 4	106.224	.802	94.688	71.879	50.423
12	.052	1.12E 4	96.947	.846	97.16	80.607	61.302
13	.06	6169.816	70.782	.713	98.514	86.979	70.474
14	.07	3569.123	54.602	.635	99.298	91.894	78.644
15	.081	1847.372	37.688	.506	99.703	95.287	85.157
16	.093	737.196	20.055	.311	99.865	97.092	89.159
17	.107	355.86	12.91	.231	99.943	98.254	92.134
18	.124	145.725	7.05	.146	99.975	98.889	94.01
19	.143	60.44	3.899	9.31E-2	99.988	99.24	95.208
20	.165	23.873	2.054	5.66E-2	99.993	99.425	95.937
21	.191	11.544	1.324	4.21E-2	99.996	99.544	96.479
22	.221	7.174	1.097	4.03E-2	99.997	99.643	96.999
23	.255	3.803	.776	3.29E-2	99.998	99.713	97.423
24	.294	2.753	.749	3.67E-2	99.999	99.78	97.895
25	.34	1.851	.672	3.80E-2	99.999	99.841	98.385
26	.392	1.667	.807	5.27E-2	100	99.913	99.064
27	.453	1.494	.964	7.27E-2	100	100	100
28	.523	0	0	0	0	0	0
29	.604	0	0	0	0	0	0
30	.698	0	0	0	0	0	0
31	.806	0	0	0	0	0	0
32	.931	0	0	0	0	0	0
TOTALS:		4.55E 5	1110.836	7.772			
FOR MEASURED DATA ONLY							
GEO. MEAN:		2.24E-2	3.58E-2	5.01E-2			
SPREAD FACTOR:		1.533	1.711	1.889			

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER
5/21/92 41K M 0.8 D/S = 175/18.5 N = 95

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL
MAXIMUM DIA. MEASURED: .457 UM START: 20:46:23
DATE: 05-21-1992 MINIMUM DIA. MEASURED: .011 UM END: 20:56:30
FILE NAME : B:\DATA\MAY21 RECORD: # 6

MOBILITY CHANNEL#	MOBILITY MIDPOINT (CM^2/(VS))	DIAMETER MIDPOINT (UM)	CPC CONCENTRATION (PART/CC)	NUMBER CONCENTRATION (PART/CC)
1	2.07E-2	.01	0	0
2	1.69E-2	.011	496.098	2.53E 4
3	1.39E-2	.012	719.974	3.18E 4
4	1.13E-2	.014	943.85	3.61E 4
5	9.30E-3	.015	1195.925	4.06E 4
6	7.61E-3	.017	1448	4.4 E 4
7	6.23E-3	.018	1535	4.14E 4
8	5.09E-3	.021	1622	3.91E 4
9	4.17E-3	.023	1751.5	3.81E 4
10	3.41E-3	.025	1881	3.70E 4
11	2.79E-3	.028	1804.5	3.21E 4
12	2.28E-3	.031	1728	2.79E 4
13	1.86E-3	.035	1504.5	2.19E 4
14	1.52E-3	.038	1281	1.73E 4
15	1.25E-3	.043	1098.411	1.38E 4
16	1.02E-3	.048	915.822	1.08E 4
17	8.37E-4	.053	701.88	7841.98
18	6.85E-4	.059	487.939	5174.8
19	5.60E-4	.066	344.473	3504.12
20	4.58E-4	.074	201.006	1961.55
21	3.75E-4	.083	130.514	1237.7
22	3.07E-4	.093	60.022	552.55
23	2.51E-4	.104	38.414	350.43
24	2.05E-4	.117	16.806	150.07
25	1.68E-4	.132	10.03	89.23
26	1.37E-4	.15	3.254	27.66
27	1.12E-4	.17	2.163	18.68
28	9.21E-5	.193	1.073	9.13
29	7.53E-5	.221	.752	6.73
30	6.16E-5	.253	.432	3.72
31	5.04E-5	.291	.296	2.81
32	4.12E-5	.337	.161	1.89
33	3.37E-5	.391	.14	1.77
34	2.76E-5	.457	.12	1.64
35	2.26E-5	.535	0	0
36	1.85E-5	.631	0	0
37	1.51E-5	.746	0	0
38	1.23E-5	.886	0	0
39	1.01E-5	1.056	0	0
		TOTALS:	2.19E 4	4.78E 5

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER

5/21/92 41K M 0.8 D/S = 175/18.5 N = 97.5

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL

MAXIMUM DIA. MEASURED: .457 UM START: 21:00:16

DATE: 05-21-1992 MINIMUM DIA. MEASURED: .011 UM END: 21:10:21

FILE NAME : B:\DATA\MAY21 RECORD: # 7

DIA CH#	DIAMETER MIDPOINT (UM)	CONCENTRATION NUMBER (#/CC)	CONCENTRATION SURFACE (UM^2/CC)	CONCENTRATION VOLUME (UM^3/CC)	PERCENTAGE NUMBER CUMULATIVE	PERCENTAGE SURFACE CUMULATIVE	PERCENTAGE VOLUME CUMULATIVE
1	0	0	0	0	0	0	0
2	.012	4.30E 4	20.814	4.30E-2	9.293	1.822	.535
3	.014	5.08E 4	32.793	7.83E-2	20.273	4.693	1.507
4	.017	5.99E 4	51.565	.142	33.219	9.208	3.273
5	.019	6.04E 4	69.398	.221	46.285	15.283	6.018
6	.022	5.76E 4	88.175	.324	58.735	23.003	10.045
7	.025	5.05E 4	103.146	.438	69.656	32.033	15.485
8	.029	4.23E 4	115.273	.565	78.808	42.125	22.505
9	.034	3.37E 4	122.389	.693	86.095	52.84	31.113
10	.039	2.36E 4	114.19	.747	91.193	62.837	40.387
11	.045	1.66E 4	107.447	.812	94.791	72.244	50.464
12	.052	1.09E 4	94.588	.825	97.166	80.524	60.708
13	.06	6058.086	69.5	.7	98.474	86.609	69.4
14	.07	3624.824	55.454	.645	99.257	91.464	77.409
15	.081	1950.495	39.792	.534	99.679	94.948	84.045
16	.093	806.499	21.941	.34	99.853	96.868	88.271
17	.107	394.868	14.325	.257	99.938	98.123	91.457
18	.124	163.416	7.906	.164	99.973	98.815	93.487
19	.143	66.05	4.261	.102	99.988	99.188	94.751
20	.165	24.889	2.141	5.90E-2	99.993	99.375	95.484
21	.191	11.786	1.352	4.30E-2	99.996	99.494	96.019
22	.221	7.516	1.15	4.22E-2	99.997	99.594	96.544
23	.255	4.125	.841	3.57E-2	99.998	99.668	96.988
24	.294	2.899	.789	3.86E-2	99.999	99.737	97.468
25	.34	1.931	.701	3.96E-2	99.999	99.798	97.961
26	.392	1.988	.962	6.28E-2	100	99.883	98.742
27	.453	2.08	1.342	.101	100	100	100
28	.523	0	0	0	0	0	0
29	.604	0	0	0	0	0	0
30	.698	0	0	0	0	0	0
31	.806	0	0	0	0	0	0
32	.931	0	0	0	0	0	0
TOTALS:		4.63E 5	1142.235	8.053			
FOR MEASURED DATA ONLY							
GEO. MEAN:		2.26E-2	3.59E-2	5.08E-2			
SPREAD FACTOR:		1.527	1.714	1.922			

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER
5/21/92 41K M 0.8 D/S = 175/18.5 N = 97.5

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL
MAXIMUM DIA. MEASURED: .457 UM START: 21:00:16
DATE: 05-21-1992 MINIMUM DIA. MEASURED: .011 UM END: 21:10:21
FILE NAME : B:\DATA\MAY21 RECORD: # 7

MOBILITY CHANNEL#	MOBILITY MIDPOINT (CM^2/(VS))	DIAMETER MIDPOINT (UM)	CPC CONCENTRATION (PART/CC)	NUMBER CONCENTRATION (PART/CC)
1	2.07E-2	.01	0	0
2	1.69E-2	.011	505.689	2.58E 4
3	1.39E-2	.012	686.502	3.03E 4
4	1.13E-2	.014	867.315	3.32E 4
5	9.30E-3	.015	1151.657	3.91E 4
6	7.61E-3	.017	1436	4.36E 4
7	6.23E-3	.018	1616	4.36E 4
8	5.09E-3	.021	1796	4.33E 4
9	4.17E-3	.023	1850.5	4.02E 4
10	3.41E-3	.025	1905	3.75E 4
11	2.79E-3	.028	1841	3.28E 4
12	2.28E-3	.031	1777	2.87E 4
13	1.86E-3	.035	1585	2.31E 4
14	1.52E-3	.038	1393	1.88E 4
15	1.25E-3	.043	1143.522	1.44E 4
16	1.02E-3	.048	894.044	1.05E 4
17	8.37E-4	.053	686.2	7652.24
18	6.85E-4	.059	478.355	5061.36
19	5.60E-4	.066	344.722	3499
20	4.58E-4	.074	211.089	2057.06
21	3.75E-4	.083	138.588	1312.78
22	3.07E-4	.093	66.087	608.46
23	2.51E-4	.104	42.474	387.89
24	2.05E-4	.117	18.862	168.86
25	1.68E-4	.132	11.144	99.38
26	1.37E-4	.15	3.427	29.03
27	1.12E-4	.17	2.265	19.41
28	9.21E-5	.193	1.103	9.27
29	7.53E-5	.221	.794	7.06
30	6.16E-5	.253	.484	4.04
31	5.04E-5	.291	.326	2.96
32	4.12E-5	.337	.167	1.96
33	3.37E-5	.391	.167	2.11
34	2.76E-5	.457	.168	2.29
35	2.26E-5	.535	0	0
36	1.85E-5	.631	0	0
37	1.51E-5	.746	0	0
38	1.23E-5	.886	0	0
39	1.01E-5	1.056	0	0
		TOTALS:	2.24E 4	4.86E 5

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER
5/21/92 41K M0.8 D/S=175/18.5 N=98.5
SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL
MAXIMUM DIA. MEASURED: .457 UM START: 21:13:49
DATE: 05-21-1992 MINIMUM DIA. MEASURED: .011 UM END: 21:24:00
FILE NAME : B:\DATA\MAY21 RECORD: # 8

DIA CH#	DIAMETER MIDPOINT (UM)	CONCENTRATION NUMBER (#/CC)	CONCENTRATION SURFACE (UM^2/CC)	CONCENTRATION VOLUME (UM^3/CC)	PERCENTAGE CUMULATIVE PERCENTAGE NUMBER	PERCENTAGE CUMULATIVE PERCENTAGE SURFACE	PERCENTAGE CUMULATIVE PERCENTAGE VOLUME
1	0	0	0	0	0	0	0
2	.012	4.15E 4	20.087	4.15E-2	9.194	1.828	.549
3	.014	5.06E 4	32.658	7.8 E-2	20.404	4.801	1.58
4	.017	5.83E 4	50.225	.139	33.332	9.372	3.411
5	.019	5.71E 4	65.552	.209	45.984	15.339	6.171
6	.022	5.48E 4	83.964	.309	58.138	22.981	10.253
7	.025	5.02E 4	102.522	.435	69.266	32.313	16.008
8	.029	4.33E 4	117.895	.578	78.862	43.043	23.651
9	.034	3.43E 4	124.534	.705	86.463	54.378	32.974
10	.039	2.30E 4	111.331	.728	91.559	64.512	42.599
11	.045	1.58E 4	102.262	.772	95.069	73.82	52.808
12	.052	1.03E 4	89.109	.777	97.363	81.93	63.081
13	.06	5730.461	65.741	.662	98.632	87.914	71.833
14	.07	3261.815	49.901	.58	99.354	92.456	79.504
15	.081	1674.454	34.16	.459	99.725	95.565	85.569
16	.093	689.563	18.76	.291	99.877	97.273	89.415
17	.107	321.392	11.66	.209	99.949	98.334	92.175
18	.124	121.527	5.879	.122	99.976	98.869	93.782
19	.143	53.397	3.445	8.22E-2	99.987	99.183	94.87
20	.165	23.051	1.983	5.46E-2	99.992	99.363	95.593
21	.191	11.766	1.35	4.29E-2	99.995	99.486	96.161
22	.221	8.153	1.247	4.58E-2	99.997	99.6	96.767
23	.255	5.454	1.113	4.72E-2	99.998	99.701	97.392
24	.294	3.848	1.047	5.13E-2	99.999	99.796	98.071
25	.34	2.217	.804	4.55E-2	99.999	99.869	98.673
26	.392	1.63	.788	5.15E-2	100	99.941	99.354
27	.453	1.003	.647	4.88E-2	100	100	100
28	.523	0	0	0	0	0	0
29	.604	0	0	0	0	0	0
30	.698	0	0	0	0	0	0
31	.806	0	0	0	0	0	0
32	.931	0	0	0	0	0	0
TOTALS:		4.51E 5	1098.665	7.565			
FOR MEASURED DATA ONLY							
GEO. MEAN:		2.26E-2	3.54E-2	4.92E-2			
SPREAD FACTOR:		1.522	1.694	1.891			

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER
5/21/92 41K M0.8 D/S=175/18.5 N=98.5

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL
MAXIMUM DIA. MEASURED: .457 UM START: 21:13:49
DATE: 05-21-1992 MINIMUM DIA. MEASURED: .011 UM END: 21:24:00
FILE NAME : B:\DATA\MAY21 RECORD: # 8

MOBILITY CHANNEL#	MOBILITY MIDPOINT (CM^2/(VS))	DIAMETER MIDPOINT (UM)	CPC CONCENTRATION (PART/CC)	NUMBER CONCENTRATION (PART/CC)
1	2.07E-2	.01	0	0
2	1.69E-2	.011	441.277	2.25E 4
3	1.39E-2	.012	657.507	2.90E 4
4	1.13E-2	.014	873.736	3.34E 4
5	9.30E-3	.015	1135.868	3.86E 4
6	7.61E-3	.017	1398	4.24E 4
7	6.23E-3	.018	1537.5	4.14E 4
8	5.09E-3	.021	1677	4.04E 4
9	4.17E-3	.023	1784	3.88E 4
10	3.41E-3	.025	1891	3.72E 4
11	2.79E-3	.028	1864	3.32E 4
12	2.28E-3	.031	1837	2.97E 4
13	1.86E-3	.035	1599.5	2.34E 4
14	1.52E-3	.038	1362	1.84E 4
15	1.25E-3	.043	1099.963	1.38E 4
16	1.02E-3	.048	837.925	9914.61
17	8.37E-4	.053	645.914	7219.86
18	6.85E-4	.059	453.902	4815.38
19	5.60E-4	.066	317.378	3227.74
20	4.58E-4	.074	180.853	1765.17
21	3.75E-4	.083	118.684	1127.32
22	3.07E-4	.093	56.514	521.12
23	2.51E-4	.104	35.265	321.13
24	2.05E-4	.117	14.017	124.13
25	1.68E-4	.132	8.595	75.63
26	1.37E-4	.15	3.174	26.49
27	1.12E-4	.17	2.154	18.11
28	9.21E-5	.193	1.133	9.45
29	7.53E-5	.221	.854	7.66
30	6.16E-5	.253	.574	5.34
31	5.04E-5	.291	.384	3.95
32	4.12E-5	.337	.194	2.28
33	3.37E-5	.391	.137	1.73
34	2.76E-5	.457	8 E-2	1.09
35	2.26E-5	.535	0	0
36	1.85E-5	.631	0	0
37	1.51E-5	.746	0	0
38	1.23E-5	.886	0	0
39	1.01E-5	1.056	0	0
		TOTALS:	2.18E 4	4.72E 5

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER
5/21/92 41K M0.8 D/S=175/18.5 N=100

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL
MAXIMUM DIA. MEASURED: .457 UM START: 21:29:46
DATE: 05-21-1992 MINIMUM DIA. MEASURED: .011 UM END: 21:39:56
FILE NAME : B:\DATA\MAY21 RECORD: # 9

DIA CH#	DIAMETER MIDPOINT (UM)	CONCENTRATION NUMBER (#/CC)	CONCENTRATION SURFACE (UM^2/CC)	CONCENTRATION VOLUME (UM^3/CC)	PERCENTAGE NUMBER CUMULATIVE	PERCENTAGE SURFACE CUMULATIVE	PERCENTAGE VOLUME CUMULATIVE
1	0	0	0	0	0	0	0
2	.012	3.52E 4	17.07	3.53E-2	8.47	1.669	.494
3	.014	4.42E 4	28.565	6.82E-2	19.1	4.461	1.448
4	.017	5.39E 4	46.431	.128	32.056	9	3.24
5	.019	5.53E 4	63.528	.202	45.35	15.21	6.07
6	.022	5.36E 4	82.051	.302	58.225	23.231	10.291
7	.025	4.79E 4	97.72	.415	69.725	32.784	16.097
8	.029	3.91E 4	106.526	.522	79.125	43.198	23.405
9	.034	3.03E 4	110.085	.623	86.409	53.959	32.127
10	.039	2.06E 4	99.814	.653	91.362	63.716	41.259
11	.045	1.48E 4	96.009	.725	94.935	73.102	51.402
12	.052	9861.214	84.836	.74	97.302	81.395	61.752
13	.06	5276.508	60.534	.61	98.569	87.313	70.281
14	.07	3100.01	47.426	.552	99.313	91.949	77.996
15	.081	1639.14	33.44	.449	99.707	95.218	84.279
16	.093	670.655	18.245	.283	99.868	97.001	88.237
17	.107	311.542	11.302	.202	99.942	98.106	91.069
18	.124	118.905	5.752	.119	99.971	98.669	92.733
19	.143	56.384	3.638	8.68E-2	99.985	99.024	93.948
20	.165	26.951	2.319	6.39E-2	99.991	99.251	94.843
21	.191	14.091	1.617	5.14E-2	99.994	99.409	95.563
22	.221	9.184	1.405	5.16E-2	99.997	99.546	96.286
23	.255	5.226	1.066	4.52E-2	99.998	99.651	96.919
24	.294	3.637	.989	4.85E-2	99.999	99.747	97.598
25	.34	2.149	.78	4.41E-2	99.999	99.823	98.216
26	.392	1.809	.875	5.72E-2	100	99.909	99.017
27	.453	1.443	.931	7.03E-2	100	100	100
28	.523	0	0	0	0	0	0
29	.604	0	0	0	0	0	0
30	.698	0	0	0	0	0	0
31	.806	0	0	0	0	0	0
32	.931	0	0	0	0	0	0
TOTALS:		4.16E 5	1022.952	7.149			
FOR MEASURED DATA ONLY							
GEO. MEAN:		2.27E-2	3.56E-2	5.05E-2			
SPREAD FACTOR:		1.517	1.708	1.936			

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER
5/21/92 41K M0.8 D/S=175/18.5 N=100

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL
MAXIMUM DIA. MEASURED: .457 UM START: 21:29:46
DATE: 05-21-1992 MINIMUM DIA. MEASURED: .011 UM END: 21:39:56
FILE NAME : B:\DATA\MAY21 RECORD: # 9

MOBILITY CHANNEL#	MOBILITY MIDPOINT (CM^2/(VS))	DIAMETER MIDPOINT (UM)	CPC CONCENTRATION (PART/CC)	NUMBER CONCENTRATION (PART/CC)
1	2.07E-2	.01	0	0
2	1.69E-2	.011	376.829	1.92E 4
3	1.39E-2	.012	558.966	2.47E 4
4	1.13E-2	.014	741.104	2.83E 4
5	9.30E-3	.015	1019.052	3.46E 4
6	7.61E-3	.017	1297	3.93E 4
7	6.23E-3	.018	1475	3.98E 4
8	5.09E-3	.021	1653	3.99E 4
9	4.17E-3	.023	1732.5	3.77E 4
10	3.41E-3	.025	1812	3.57E 4
11	2.79E-3	.028	1716.5	3.06E 4
12	2.28E-3	.031	1621	2.62E 4
13	1.86E-3	.035	1417.5	2.07E 4
14	1.52E-3	.038	1214	1.64E 4
15	1.25E-3	.043	1010.975	1.27E 4
16	1.02E-3	.048	807.951	9563.04
17	8.37E-4	.053	612.508	6841.21
18	6.85E-4	.059	417.064	4417.91
19	5.60E-4	.066	297.146	3019.38
20	4.58E-4	.074	177.227	1729.96
21	3.75E-4	.083	116.118	1102.68
22	3.07E-4	.093	55.01	506.26
23	2.51E-4	.104	34.333	311.4
24	2.05E-4	.117	13.657	120.05
25	1.68E-4	.132	8.652	75.67
26	1.37E-4	.15	3.647	30.66
27	1.12E-4	.17	2.49	21.28
28	9.21E-5	.193	1.333	11.38
29	7.53E-5	.221	.951	8.62
30	6.16E-5	.253	.568	5.12
31	5.04E-5	.291	.377	3.73
32	4.12E-5	.337	.187	2.2
33	3.37E-5	.391	.152	1.92
34	2.76E-5	.457	.116	1.58
35	2.26E-5	.535	0	0
36	1.85E-5	.631	0	0
37	1.51E-5	.746	0	0
38	1.23E-5	.886	0	0
39	1.01E-5	1.056	0	0
		TOTALS:	2.01E 4	4.34E 5

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER
5/21/92 45K M0.8 D/S=175/18.5 N=95
SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL
MAXIMUM DIA. MEASURED: .457 UM START: 21:51:22
DATE: 05-21-1992 MINIMUM DIA. MEASURED: .011 UM END: 22:01:39
FILE NAME : B:\DATA\MAY21 RECORD: # 10

DIA CH#	DIAMETER MIDPOINT (UM)	CONCENTRATION NUMBER (#/CC)	CONCENTRATION SURFACE (UM^2/CC)	CONCENTRATION VOLUME (UM^3/CC)	PERCENTAGE NUMBER CUMULATIVE	PERCENTAGE SURFACE CUMULATIVE	PERCENTAGE VOLUME CUMULATIVE
1	0	0	0	0	0	0	0
2	.012	3.08E 4	14.918	3.08E-2	10.824	2.542	.82
3	.014	3.68E 4	23.775	5.67E-2	23.761	6.594	2.329
4	.017	4.23E 4	36.45	.101	38.633	12.806	5
5	.019	4.02E 4	46.131	.147	52.749	20.667	8.905
6	.022	3.62E 4	55.487	.204	65.48	30.123	14.328
7	.025	2.96E 4	60.554	.257	75.899	40.442	21.162
8	.029	2.29E 4	62.525	.307	83.967	51.098	29.311
9	.034	1.71E 4	62.02	.351	89.968	61.667	38.645
10	.039	1.11E 4	53.988	.353	93.886	70.867	48.028
11	.045	7887.132	50.883	.384	96.654	79.538	58.24
12	.052	4993.157	42.956	.375	98.407	86.859	68.196
13	.06	2352.918	26.993	.272	99.233	91.459	75.42
14	.07	1212.535	18.55	.216	99.658	94.62	81.154
15	.081	548.197	11.184	.15	99.851	96.526	85.145
16	.093	209.455	5.698	8.83E-2	99.924	97.497	87.494
17	.107	101.765	3.692	6.61E-2	99.96	98.126	89.251
18	.124	45.302	2.192	4.53E-2	99.976	98.5	90.455
19	.143	24.906	1.607	3.83E-2	99.985	98.774	91.475
20	.165	14.811	1.274	3.51E-2	99.99	98.991	92.409
21	.191	9.846	1.13	3.59E-2	99.993	99.183	93.365
22	.221	7.037	1.077	3.96E-2	99.996	99.367	94.417
23	.255	4.399	.897	3.81E-2	99.997	99.52	95.43
24	.294	3.049	.83	4.06E-2	99.999	99.661	96.511
25	.34	1.755	.637	3.60E-2	99.999	99.77	97.469
26	.392	1.404	.679	4.44E-2	100	99.885	98.65
27	.453	1.043	.673	5.08E-2	100	100	100
28	.523	0	0	0	0	0	0
29	.604	0	0	0	0	0	0
30	.698	0	0	0	0	0	0
31	.806	0	0	0	0	0	0
32	.931	0	0	0	0	0	0
TOTALS:		2.84E 5	586.798	3.763			
FOR MEASURED DATA ONLY							
GEO. MEAN:		2.11E-2	3.23E-2	4.77E-2			
SPREAD FACTOR:		1.483	1.713	2.087			

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER
5/21/92 45K M0.8 D/S=175/18.5 N=95

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL
MAXIMUM DIA. MEASURED: .457 UM START: 21:51:22
DATE: 05-21-1992 MINIMUM DIA. MEASURED: .011 UM END: 22:01:39
FILE NAME : B:\DATA\MAY21 RECORD: # 10

MOBILITY CHANNEL#	MOBILITY MIDPOINT (CM^2/(VS))	DIAMETER MIDPOINT (UM)	CPC CONCENTRATION (PART/CC)	NUMBER CONCENTRATION (PART/CC)
1	2.07E-2	.01	0	0
2	1.69E-2	.011	343.552	1.75E 4
3	1.39E-2	.012	490.001	2.16E 4
4	1.13E-2	.014	636.45	2.43E 4
5	9.30E-3	.015	826.225	2.80E 4
6	7.61E-3	.017	1016	3.08E 4
7	6.23E-3	.018	1089	2.94E 4
8	5.09E-3	.021	1162	2.80E 4
9	4.17E-3	.023	1142.5	2.49E 4
10	3.41E-3	.025	1123	2.21E 4
11	2.79E-3	.028	1025.015	1.83E 4
12	2.28E-3	.031	927.029	1.50E 4
13	1.86E-3	.035	792.003	1.15E 4
14	1.52E-3	.038	656.976	8917.19
15	1.25E-3	.043	538.749	6824.18
16	1.02E-3	.048	420.522	5007.81
17	8.37E-4	.053	303.911	3421.12
18	6.85E-4	.059	187.3	1997.97
19	5.60E-4	.066	123.711	1263.85
20	4.58E-4	.074	60.122	586.75
21	3.75E-4	.083	38.623	365.28
22	3.07E-4	.093	17.123	155.49
23	2.51E-4	.104	11.192	99.51
24	2.05E-4	.117	5.261	44.64
25	1.68E-4	.132	3.611	30.14
26	1.37E-4	.15	1.96	15.65
27	1.12E-4	.17	1.477	12.1
28	9.21E-5	.193	.994	8.38
29	7.53E-5	.221	.733	6.61
30	6.16E-5	.253	.471	4.31
31	5.04E-5	.291	.312	3.13
32	4.12E-5	.337	.153	1.8
33	3.37E-5	.391	.118	1.49
34	2.76E-5	.457	8.38E-2	1.14
35	2.26E-5	.535	0	0
36	1.85E-5	.631	0	0
37	1.51E-5	.746	0	0
38	1.23E-5	.886	0	0
39	1.01E-5	1.056	0	0
		TOTALS:	1.29E 4	3.00E 5

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER
5/21/92 45K M0.8 D/S=175/18.5 N=97.5

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL
MAXIMUM DIA. MEASURED: .457 UM START: 22:04:25
DATE: 05-21-1992 MINIMUM DIA. MEASURED: .011 UM END: 22:14:29
FILE NAME : B:\DATA\MAY21 RECORD: # 11

DIA CH#	DIAMETER MIDPOINT (UM)	CONCENTRATION NUMBER (#/CC)	CONCENTRATION SURFACE (UM^2/CC)	CONCENTRATION VOLUME (UM^3/CC)	PERCENTAGE NUMBER CUMULATIVE	PERCENTAGE SURFACE CUMULATIVE	PERCENTAGE VOLUME CUMULATIVE
1	0	0	0	0	0	0	0
2	.012	2.57E 4	12.459	2.57E-2	10.04	2.228	.654
3	.014	3.12E 4	20.179	4.81E-2	22.233	5.837	1.878
4	.017	3.59E 4	30.955	8.53E-2	36.259	11.373	4.047
5	.019	3.58E 4	41.099	.131	50.224	18.724	7.371
6	.022	3.36E 4	51.515	.189	63.351	27.937	12.183
7	.025	2.86E 4	58.439	.248	74.517	38.389	18.487
8	.029	2.18E 4	59.307	.291	83.016	48.995	25.874
9	.034	1.60E 4	58.207	.33	89.27	59.405	34.247
10	.039	1.04E 4	50.622	.331	93.349	68.459	42.656
11	.045	7376.765	47.59	.359	96.225	76.97	51.785
12	.052	4744.541	40.817	.356	98.074	84.27	60.826
13	.06	2397.603	27.506	.277	99.009	89.19	67.862
14	.07	1348.876	20.636	.24	99.535	92.88	73.957
15	.081	677.867	13.829	.186	99.799	95.354	78.675
16	.093	267.063	7.265	.113	99.903	96.653	81.537
17	.107	125.79	4.563	8.17E-2	99.952	97.469	83.612
18	.124	51.299	2.482	5.13E-2	99.972	97.913	84.916
19	.143	26.696	1.722	4.11E-2	99.983	98.221	85.961
20	.165	14.795	1.273	3.51E-2	99.988	98.449	86.852
21	.191	9.148	1.049	3.34E-2	99.992	98.636	87.701
22	.221	6.246	.956	3.51E-2	99.994	98.807	88.594
23	.255	2.412	.492	2.09E-2	99.995	98.895	89.124
24	.294	1.445	.393	1.92E-2	99.996	98.966	89.614
25	.34	1.617	.586	3.32E-2	99.997	99.07	90.458
26	.392	3.438	1.663	.109	99.998	99.368	93.221
27	.453	5.478	3.534	.267	100	100	100
28	.523	0	0	0	0	0	0
29	.604	0	0	0	0	0	0
30	.698	0	0	0	0	0	0
31	.806	0	0	0	0	0	0
32	.931	0	0	0	0	0	0
TOTALS:		2.56E 5	559.139	3.937			
FOR MEASURED DATA ONLY							
GEO. MEAN:		2.16E-2	3.38E-2	5.68E-2			
SPREAD FACTOR:		1.491	1.783	2.436			

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER
5/21/92 45K M0.8 D/S=175/18.5 N=97.5
SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL
MAXIMUM DIA. MEASURED: .457 UM START: 22:04:25
DATE: 05-21-1992 MINIMUM DIA. MEASURED: .011 UM END: 22:14:29
FILE NAME : B:\DATA\MAY21 RECORD: # 11

MOBILITY CHANNEL#	MOBILITY MIDPOINT (CM^2/(VS))	DIAMETER MIDPOINT (UM)	CPC CONCENTRATION (PART/CC)	NUMBER CONCENTRATION (PART/CC)
1	2.07E-2	.01	0	0
2	1.69E-2	.011	274.907	1.40E 4
3	1.39E-2	.012	407.965	1.80E 4
4	1.13E-2	.014	541.023	2.07E 4
5	9.30E-3	.015	700.546	2.38E 4
6	7.61E-3	.017	860.068	2.61E 4
7	6.23E-3	.018	959.034	2.59E 4
8	5.09E-3	.021	1058	2.55E 4
9	4.17E-3	.023	1073.5	2.34E 4
10	3.41E-3	.025	1089	2.15E 4
11	2.79E-3	.028	979.504	1.74E 4
12	2.28E-3	.031	870.007	1.41E 4
13	1.86E-3	.035	743.384	1.08E 4
14	1.52E-3	.038	616.761	8364.49
15	1.25E-3	.043	505.427	6389.96
16	1.02E-3	.048	394.094	4676.97
17	8.37E-4	.053	292.007	3271.84
18	6.85E-4	.059	189.92	2017.24
19	5.60E-4	.066	131.881	1343.07
20	4.58E-4	.074	73.842	720.97
21	3.75E-4	.083	47.846	453.64
22	3.07E-4	.093	21.85	199.89
23	2.51E-4	.104	13.875	124.72
24	2.05E-4	.117	5.901	50.96
25	1.68E-4	.132	3.964	33.64
26	1.37E-4	.15	2.027	15.92
27	1.12E-4	.17	1.491	11.99
28	9.21E-5	.193	.955	7.67
29	7.53E-5	.221	.697	5.89
30	6.16E-5	.253	.439	2.38
31	5.04E-5	.291	.286	1.44
32	4.12E-5	.337	.133	1.56
33	3.37E-5	.391	.289	3.65
34	2.76E-5	.457	.445	6.07
35	2.26E-5	.535	0	0
36	1.85E-5	.631	0	0
37	1.51E-5	.746	0	0
38	1.23E-5	.886	0	0
39	1.01E-5	1.056	0	0
		TOTALS:	1.18E 4	2.69E 5

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER
5/21/92 45K M0.8 D/S=175/18.5 N=98.5
SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL
MAXIMUM DIA. MEASURED: .457 UM START: 22:16:53
DATE: 05-21-1992 MINIMUM DIA. MEASURED: .011 UM END: 22:27:00
FILE NAME : B:\DATA\MAY21 RECORD: # 12

DIA CH#	DIAMETER MIDPOINT (UM)	CONCENTRATION NUMBER (#/CC)	CONCENTRATION SURFACE (UM^2/CC)	CONCENTRATION VOLUME (UM^3/CC)	PERCENTAGE NUMBER CUMULATIVE	PERCENTAGE SURFACE CUMULATIVE	PERCENTAGE VOLUME CUMULATIVE
1	0	0	0	0	0	0	0
2	.012	2.25E 4	10.918	2.25E-2	9.264	2.029	.612
3	.014	2.88E 4	18.638	4.45E-2	21.123	5.493	1.818
4	.017	3.49E 4	30.103	8.30E-2	35.485	11.088	4.067
5	.019	3.36E 4	38.56	.123	49.282	18.255	7.394
6	.022	3.11E 4	47.611	.175	62.056	27.104	12.139
7	.025	2.68E 4	54.863	.233	73.095	37.301	18.451
8	.029	2.17E 4	59.248	.291	82.034	48.312	26.324
9	.034	1.66E 4	60.397	.342	88.868	59.538	35.592
10	.039	1.09E 4	52.777	.345	93.346	69.347	44.943
11	.045	7233.334	46.665	.352	96.315	78.02	54.492
12	.052	4475.716	38.505	.336	98.152	85.176	63.59
13	.06	2239.701	25.694	.259	99.071	89.952	70.601
14	.07	1197.887	18.326	.213	99.563	93.358	76.376
15	.081	576.73	11.766	.158	99.8	95.544	80.657
16	.093	241.595	6.573	.102	99.899	96.766	83.419
17	.107	119.265	4.327	7.74E-2	99.948	97.57	85.519
18	.124	53.037	2.566	5.30E-2	99.969	98.047	86.956
19	.143	29.182	1.883	4.49E-2	99.981	98.397	88.174
20	.165	16.46	1.416	3.90E-2	99.988	98.66	89.233
21	.191	9.359	1.074	3.41E-2	99.992	98.86	90.159
22	.221	6.387	.977	3.59E-2	99.995	99.041	91.133
23	.255	3.312	.676	2.86E-2	99.996	99.167	91.91
24	.294	2.237	.608	2.98E-2	99.997	99.28	92.719
25	.34	1.743	.632	3.58E-2	99.998	99.397	93.689
26	.392	2.43	1.176	7.69E-2	99.999	99.616	95.772
27	.453	3.203	2.066	.156	100	100	100
28	.523	0	0	0	0	0	0
29	.604	0	0	0	0	0	0
30	.698	0	0	0	0	0	0
31	.806	0	0	0	0	0	0
32	.931	0	0	0	0	0	0
TOTALS:		2.43E 5	538.043	3.691			
FOR MEASURED DATA ONLY							
GEO. MEAN:		2.18E-2	3.37E-2	5.34E-2			
SPREAD FACTOR:		1.49	1.747	2.286			

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER
5/21/92 45K M0.8 D/S=175/18.5 N=98.5

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL
MAXIMUM DIA. MEASURED: .457 UM START: 22:16:53
DATE: 05-21-1992 MINIMUM DIA. MEASURED: .011 UM END: 22:27:00
FILE NAME : B:\DATA\MAY21 RECORD: # 12

MOBILITY CHANNEL#	MOBILITY MIDPOINT (CM^2/(VS))	DIAMETER MIDPOINT (UM)	CPC CONCENTRATION (PART/CC)	NUMBER CONCENTRATION (PART/CC)
1	2.07E-2	.01	0	0
2	1.69E-2	.011	228.239	1.16E 4
3	1.39E-2	.012	356.151	1.57E 4
4	1.13E-2	.014	484.064	1.85E 4
5	9.30E-3	.015	664.098	2.25E 4
6	7.61E-3	.017	844.132	2.56E 4
7	6.23E-3	.018	909.372	2.45E 4
8	5.09E-3	.021	974.613	2.35E 4
9	4.17E-3	.023	995.307	2.16E 4
10	3.41E-3	.025	1016	2.00E 4
11	2.79E-3	.028	956.37	1.70E 4
12	2.28E-3	.031	896.739	1.45E 4
13	1.86E-3	.035	772.033	1.13E 4
14	1.52E-3	.038	647.327	8797.17
15	1.25E-3	.043	509.439	6451.3
16	1.02E-3	.048	371.551	4414.93
17	8.37E-4	.053	274.842	3085.81
18	6.85E-4	.059	178.133	1894.76
19	5.60E-4	.066	120.23	1223.95
20	4.58E-4	.074	62.328	606.39
21	3.75E-4	.083	41.208	388.96
22	3.07E-4	.093	20.088	182.68
23	2.51E-4	.104	13.077	116.69
24	2.05E-4	.117	6.067	52.15
25	1.68E-4	.132	4.16	35.42
26	1.37E-4	.15	2.253	18.27
27	1.12E-4	.17	1.597	13.15
28	9.21E-5	.193	.942	7.71
29	7.53E-5	.221	.693	6.01
30	6.16E-5	.253	.445	3.25
31	5.04E-5	.291	.296	2.27
32	4.12E-5	.337	.148	1.74
33	3.37E-5	.391	.204	2.58
34	2.76E-5	.457	.26	3.54
35	2.26E-5	.535	0	0
36	1.85E-5	.631	0	0
37	1.51E-5	.746	0	0
38	1.23E-5	.886	0	0
39	1.01E-5	1.056	0	0
		TOTALS:	1.13E 4	2.54E 5

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER
5/21/92 45K M0.8 D/S=175/18.5 N=100

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL
MAXIMUM DIA. MEASURED: .457 UM START: 22:29:22
DATE: 05-21-1992 MINIMUM DIA. MEASURED: .011 UM END: 22:39:07
FILE NAME : B:\DATA\MAY21 RECORD: # 13

DIA CH#	DIAMETER MIDPOINT (UM)	CONCENTRATION NUMBER (#/CC)	CONCENTRATION SURFACE (UM^2/CC)	CONCENTRATION VOLUME (UM^3/CC)	PERCENTAGE NUMBER CUMULATIVE	PERCENTAGE SURFACE CUMULATIVE	PERCENTAGE VOLUME CUMULATIVE
1	0	0	0	0	0	0	0
2	.012	2.00E 4	9.718	2.01E-2	9.131	1.979	.583
3	.014	2.60E 4	16.785	4.00E-2	20.958	5.398	1.745
4	.017	3.16E 4	27.234	7.51E-2	35.347	10.945	3.923
5	.019	3.11E 4	35.732	.114	49.505	18.223	7.222
6	.022	2.87E 4	44.007	.162	62.58	27.186	11.915
7	.025	2.40E 4	49.084	.208	73.516	37.183	17.959
8	.029	1.86E 4	50.843	.249	82.012	47.539	25.188
9	.034	1.43E 4	52.151	.295	88.546	58.161	33.751
10	.039	1.00E 4	48.503	.317	93.103	68.04	42.948
11	.045	6738.76	43.474	.328	96.166	76.894	52.468
12	.052	4171.372	35.886	.313	98.062	84.203	61.542
13	.06	2044.661	23.457	.236	98.992	88.981	68.391
14	.07	1141.453	17.463	.203	99.51	92.538	74.28
15	.081	576.3	11.757	.158	99.772	94.932	78.858
16	.093	242.568	6.599	.102	99.883	96.277	81.825
17	.107	121.23	4.398	7.87E-2	99.938	97.172	84.109
18	.124	55.319	2.676	5.53E-2	99.963	97.717	85.713
19	.143	31.083	2.005	4.78E-2	99.977	98.126	87.102
20	.165	18.11	1.558	4.29E-2	99.985	98.443	88.348
21	.191	10.73	1.231	3.92E-2	99.99	98.694	89.484
22	.221	7.353	1.125	4.13E-2	99.993	98.923	90.684
23	.255	4.175	.852	3.61E-2	99.995	99.097	91.733
24	.294	3.1	.843	4.13E-2	99.997	99.268	92.932
25	.34	2.315	.84	4.75E-2	99.998	99.439	94.311
26	.392	2.383	1.153	7.54E-2	99.999	99.674	96.498
27	.453	2.479	1.6	.121	100	100	100
28	.523	0	0	0	0	0	0
29	.604	0	0	0	0	0	0
30	.698	0	0	0	0	0	0
31	.806	0	0	0	0	0	0
32	.931	0	0	0	0	0	0
TOTALS:		2.2 E 5	490.974	3.449			
FOR MEASURED DATA ONLY							
GEO. MEAN:		2.18E-2	3.42E-2	5.51E-2			
SPREAD FACTOR:		1.493	1.772	2.298			

TSI DIFFERENTIAL MOBILITY PARTICLE SIZER
5/21/92 45K M0.8 D/S=175/18.5 N=100

SAMPLE # 1 AEROSOL FLOW RATE: .6 LPM MEAS. MODE: EVERY 2ND CHNL
MAXIMUM DIA. MEASURED: .457 UM START: 22:29:22
DATE: 05-21-1992 MINIMUM DIA. MEASURED: .011 UM END: 22:39:07
FILE NAME : B:\DATA\MAY21 RECORD: # 13

MOBILITY CHANNEL#	MOBILITY MIDPOINT (CM^2/(VS))	DIAMETER MIDPOINT (UM)	CPC CONCENTRATION (PART/CC)	NUMBER CONCENTRATION (PART/CC)
1	2.07E-2	.01	0	0
2	1.69E-2	.011	197.68	1.01E 4
3	1.39E-2	.012	316.425	1.39E 4
4	1.13E-2	.014	435.171	1.66E 4
5	9.30E-3	.015	598.959	2.03E 4
6	7.61E-3	.017	762.747	2.31E 4
7	6.23E-3	.018	837.521	2.26E 4
8	5.09E-3	.021	912.295	2.20E 4
9	4.17E-3	.023	912.191	1.98E 4
10	3.41E-3	.025	912.087	1.8 E 4
11	2.79E-3	.028	833.706	1.48E 4
12	2.28E-3	.031	755.325	1.22E 4
13	1.86E-3	.035	674.568	9874.57
14	1.52E-3	.038	593.81	8069.09
15	1.25E-3	.043	471.521	5971.89
16	1.02E-3	.048	349.231	4148.38
17	8.37E-4	.053	255.728	2867.13
18	6.85E-4	.059	162.225	1721.83
19	5.60E-4	.066	112.252	1140.81
20	4.58E-4	.074	62.278	605.47
21	3.75E-4	.083	41.253	388.87
22	3.07E-4	.093	20.228	183.47
23	2.51E-4	.104	13.291	118.12
24	2.05E-4	.117	6.354	54.22
25	1.68E-4	.132	4.403	37.15
26	1.37E-4	.15	2.452	19.83
27	1.12E-4	.17	1.77	14.56
28	9.21E-5	.193	1.087	8.92
29	7.53E-5	.221	.797	6.91
30	6.16E-5	.253	.507	4.08
31	5.04E-5	.291	.354	3.15
32	4.12E-5	.337	.2	2.35
33	3.37E-5	.391	.2	2.53
34	2.76E-5	.457	.2	2.73
35	2.26E-5	.535	0	0
36	1.85E-5	.631	0	0
37	1.51E-5	.746	0	0
38	1.23E-5	.886	0	0
39	1.01E-5	1.056	0	0
		TOTALS:	1.02E 4	2.29E 5

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2. Schumann, U.; and Reinhardt, M.E.: Studies on the Effect of High Flying Air Traffic on the Atmosphere. 42nd Congress of the International Astronautical Federation, Montreal, Canada. IAA Paper 91–737, October 1991.

3. Block, Bruce H.; et al.: Techniques Utilized in the Simulated Altitude Testing of a 2D-CD Vectoring and Reversing Nozzle. NASA TM–100872, 1988.

4. Naegeli, D.W.; and Moses, C.A.: Effect of Fuel Molecular Structure on Soot Formation in Gaas Turbine Engines. Paper 80–GT–62, ASME Gas Turbine Conference, New Orleans, 1980.

5. Lefebvre, Arthur H.: *Gas Turbine Combustion.* Hemisphere Publishing Corp., New York, 1983.

6. Douglas, Everett L.: Characterization of Gaseous and Particulate Size Distribution Emissions From the J85–GE–4A Engine. Navy Aircraft Environmental Support Office, AESO#4–87, May 1987.

TABLE I.—ENGINE TEST CONDITIONS

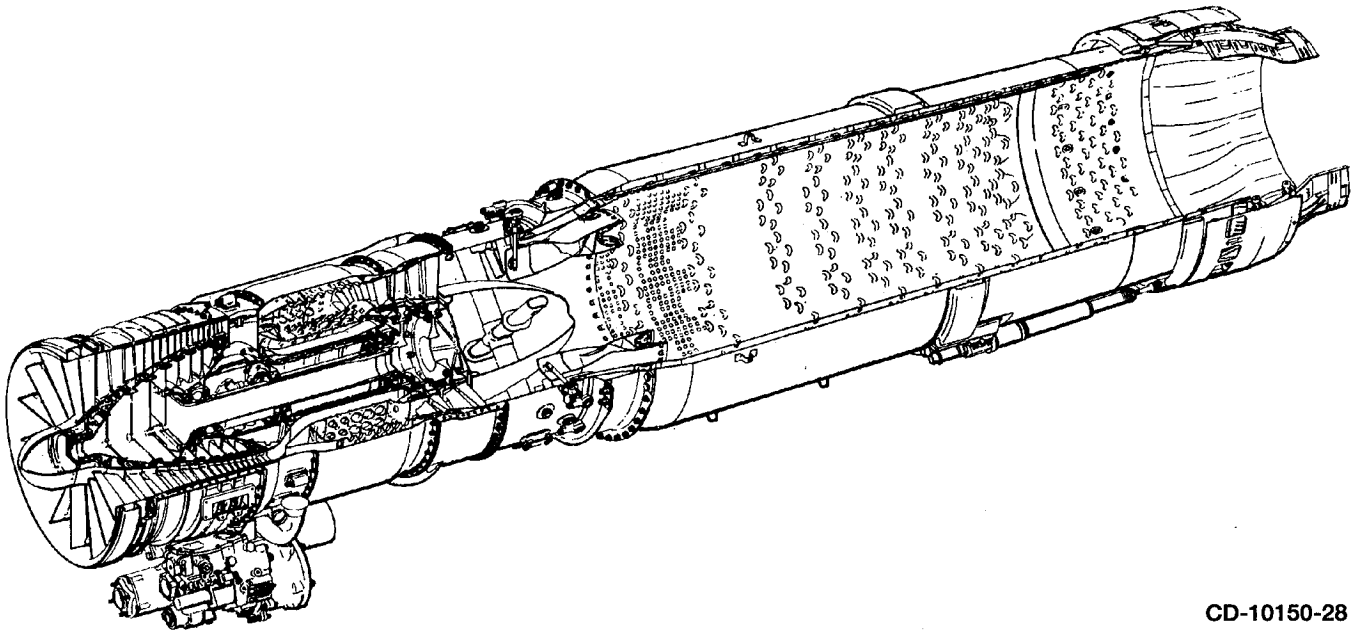
Simulated altitude, ft	Simulated Mach number	Engine inlet total pressure, psia	Engine inlet total temperature, °F	Engine speed, percent
5 000	0.5	14.54	70	95 97.5
35 000	.8	5.1	–20	93 95 97.5 100
41 000	.8	3.97	–20	95 97.5 98.5 100
45 000	.8	3.26	–20	95 97.5 98.5 100

TABLE II.—COMPARISON OF NASA AND AESO ENGINE TEST CONDITIONS

	Simulated altitude, ft	Simulated Mach number	Engine speed, percent	Combustor inlet pressure, psia	Combustor inlet temperature, °F	Fuel/ air ratio
NASA	5 000	0.5	97.5	80.5	478	0.0165
AESO	0	0	100	90.7	506	.0179

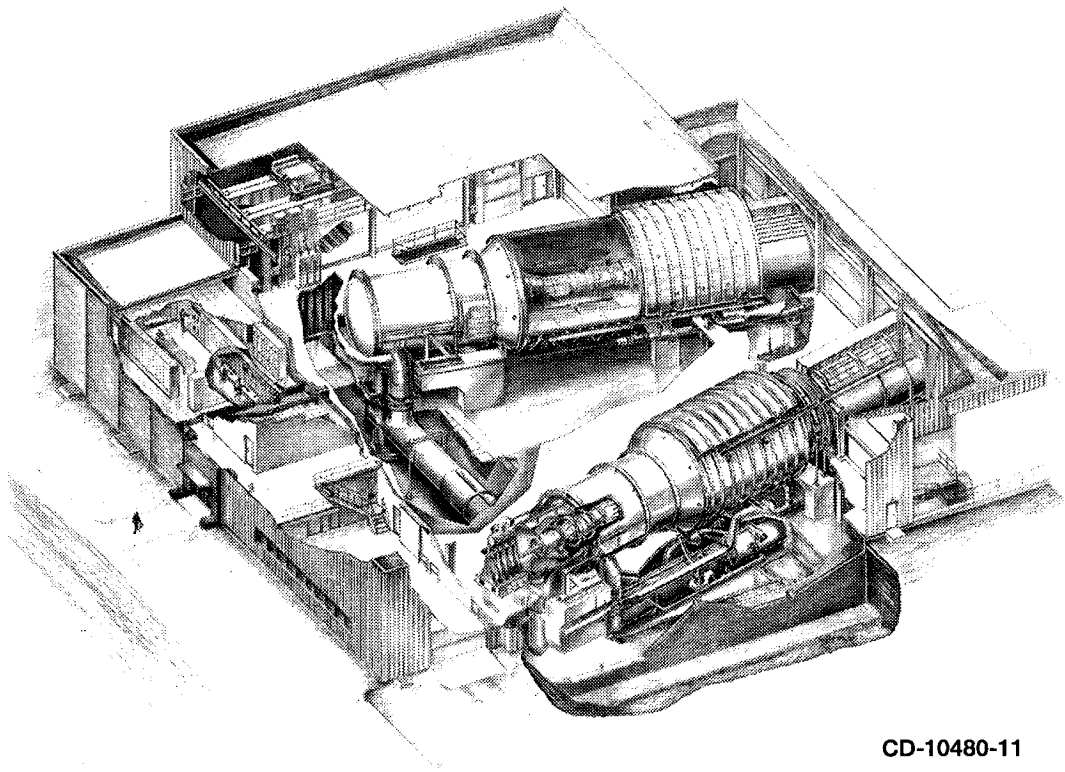
TABLE III.—SUMMARY OF J85-5 ENGINE DATA

Engine speed, percent	Fuel/air ratio	Dilution ratio	Total number count, particles/cm^3	Total particle surface area, $\mu m^2/cm^3$	Total particle volume, $\mu m^3/cm^3$	Sauter mean diameter, μm
At 5000 ft and Mach 0.5						
95	0.0126	11.15	24.3×10^6	14.2×10^4	1510	0.064
97.5	.0164	11.05	34.9	27.4	3240	.071
At 36 000 ft and Mach 0.8						
93	0.0122	11.06	7.90×10^6	2.12×10^4	160.4	0.045
95	.0134	11.12	8.04	1.99	147	.044
97.5	.0163	11.62	9.27	2.22	161	.038
100	.018	10.89	12.0	2.59	170	.039
At 41 000 ft and Mach 0.8						
95	0.0135	10.56	5.05×10^6	1.17×10^4	82	0.042
97.5	.0155	10.63	5.17	1.21	86	.043
98.5	.0186	10.17	4.80	1.12	77	.041
100	.0186	10.47	4.54	1.07	75	.042
At 45 000 ft and Mach 0.8						
95	0.0156	10.3	3.09×10^6	0.60×10^4	39	0.039
97.5	.0173	10.52	2.83	.588	41	.042
98.5	.0187	10.51	2.67	.565	39	.041
100	.0187	10.37	2.37	.509	36	.042



CD-10150-28

Figure 1.—Cutaway of J85-GE-5L afterburning turbojet engine.



CD-10480-11

Figure 2.—Cutaway of Propulsion Systems Laboratory.

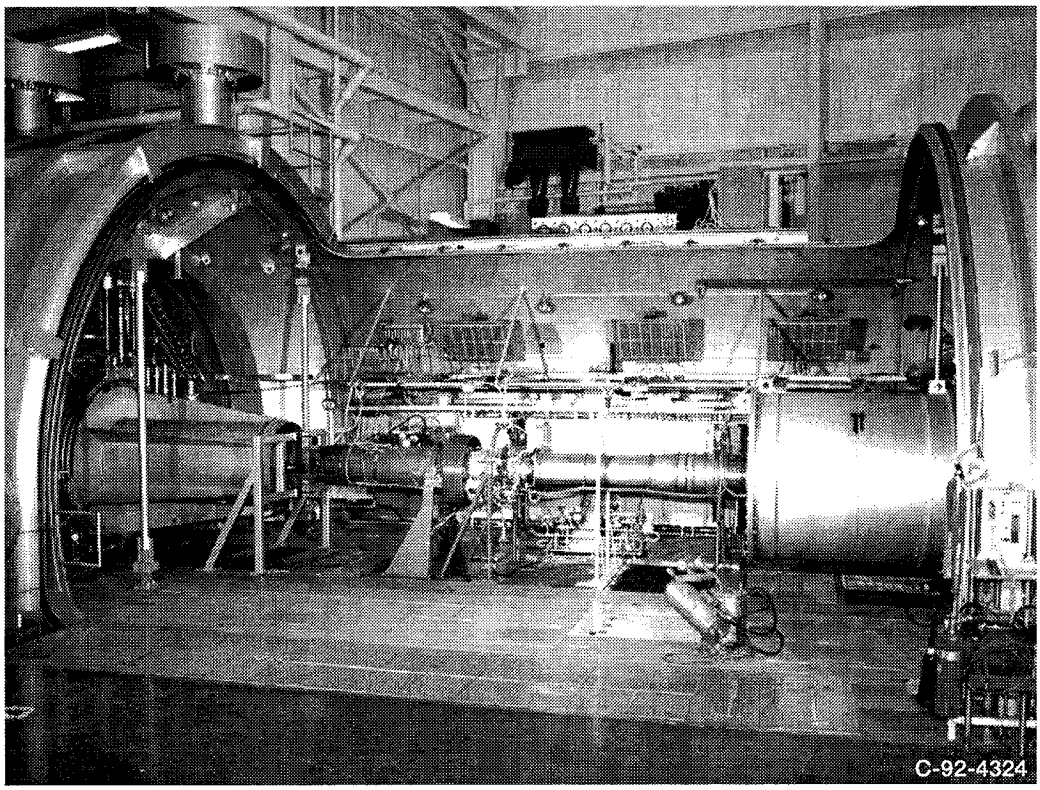


Figure 3.—J85-GE-5 engine installed in PSL-4 altitude test chamber.

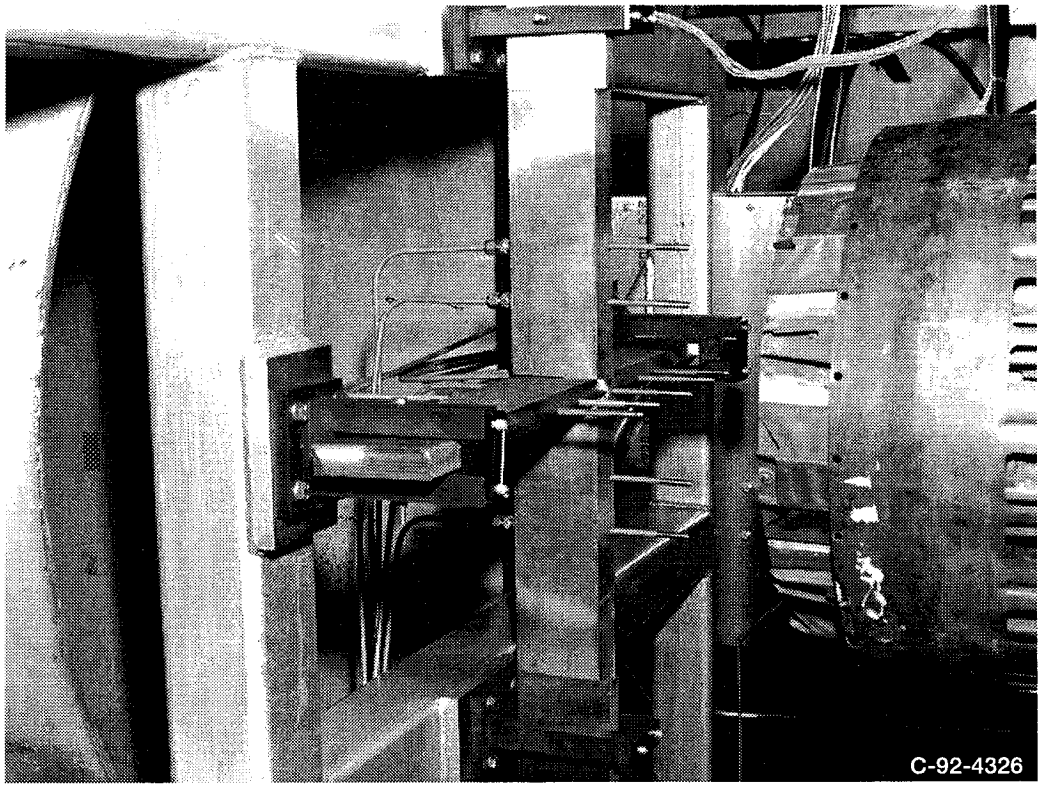


Figure 4.—Particle sampling probe.

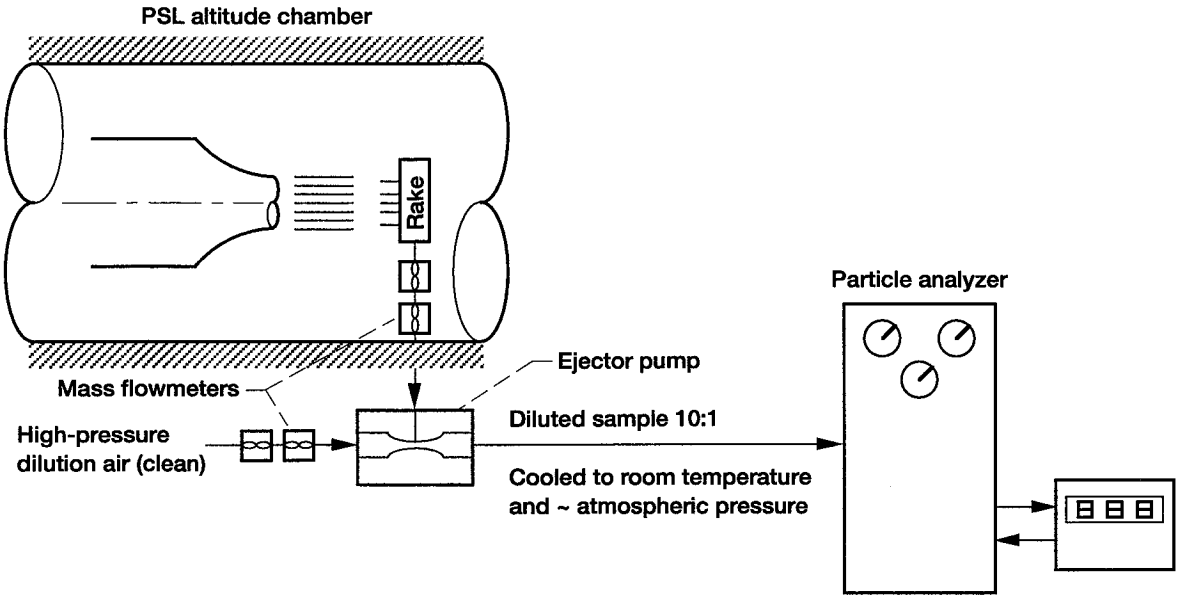


Figure 5.—Schematic of particle analyzer system.

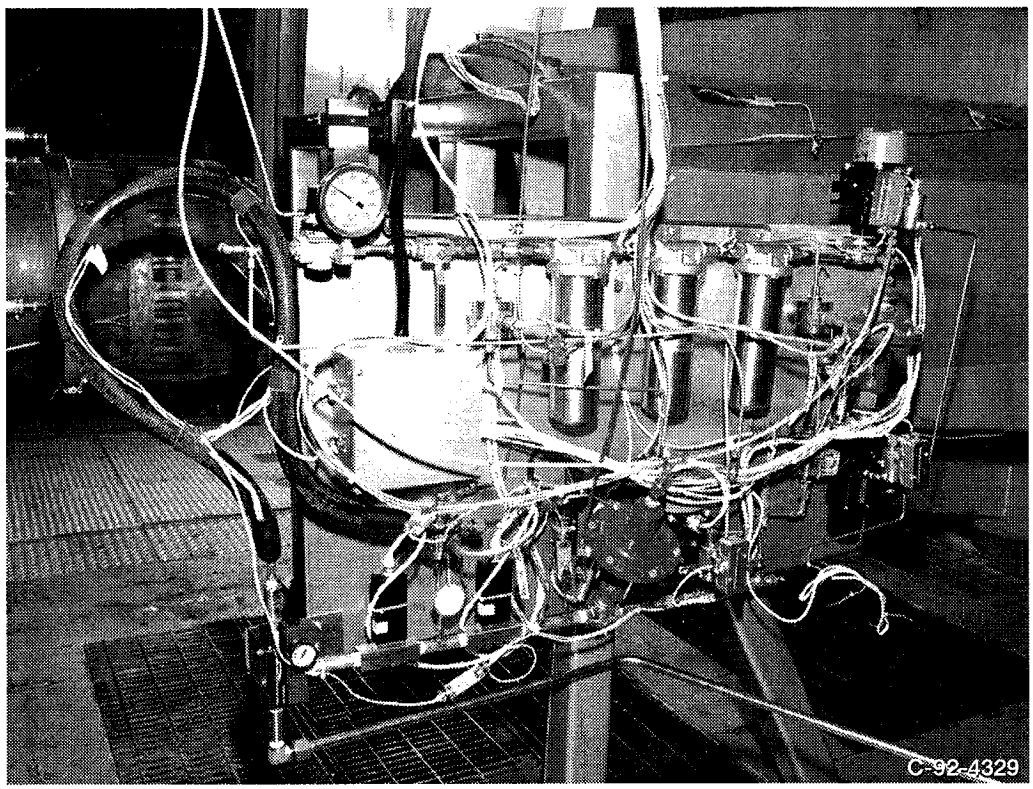


Figure 6.—Particle sampling system.

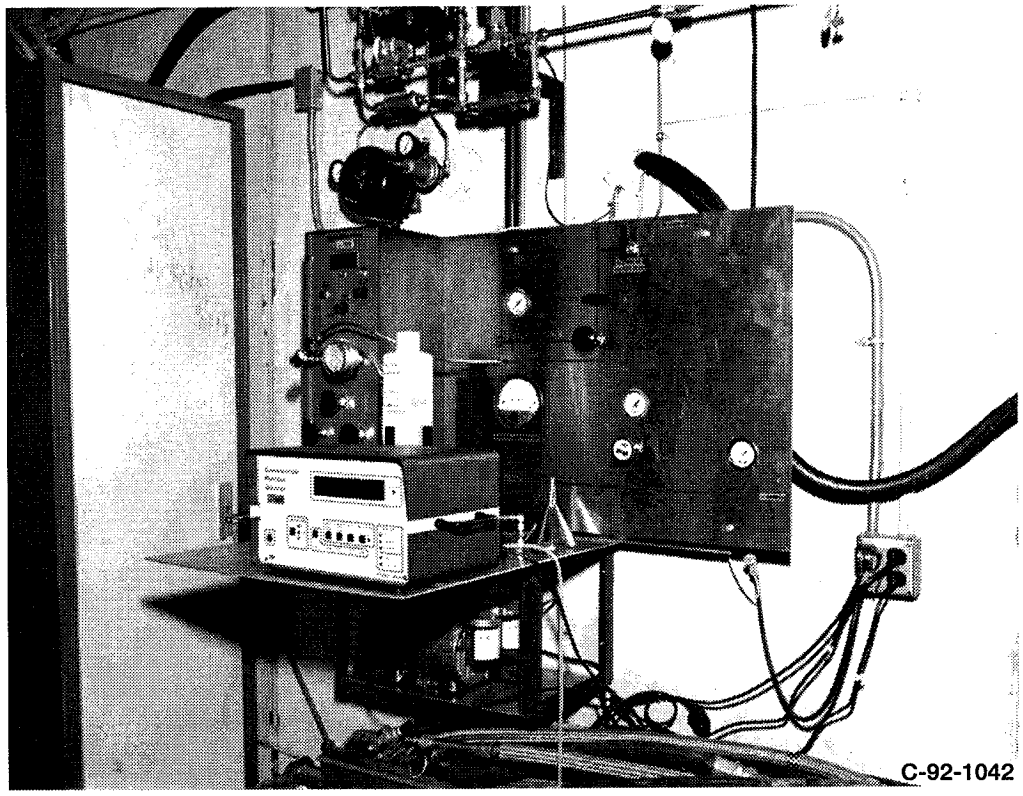


Figure 7.—TSI differential mobility particle analyzer system.

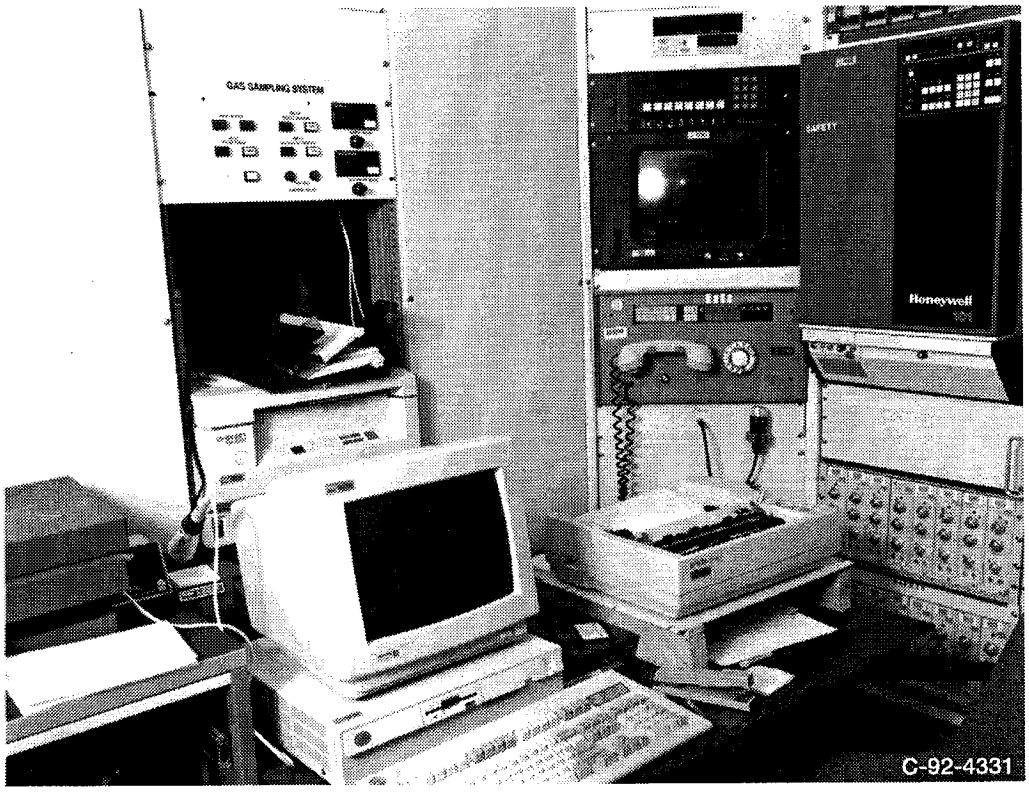


Figure 8.—TSI particle analyzer computer system.

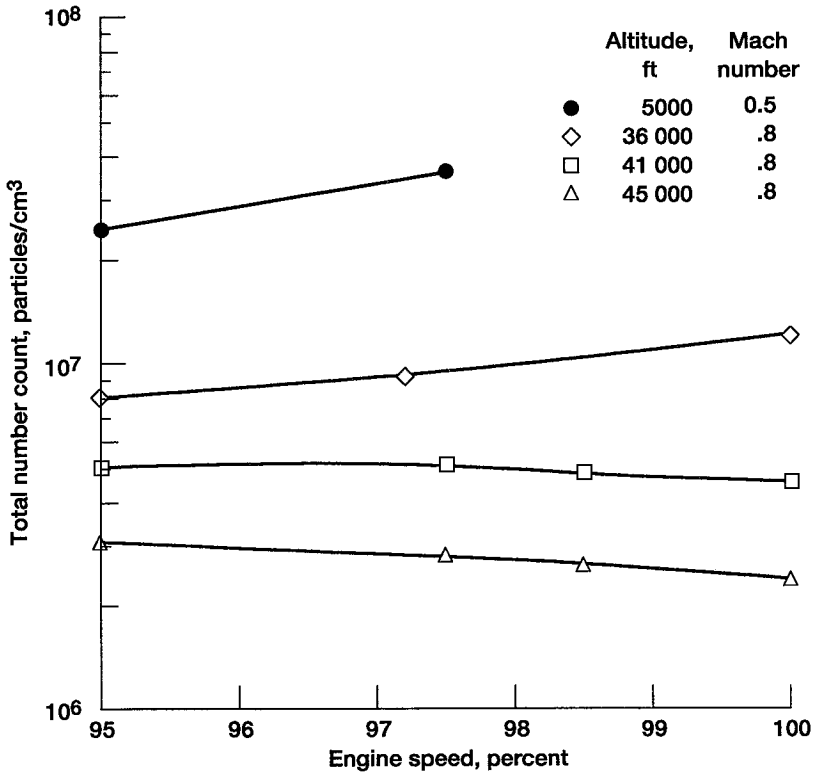


Figure 9.—Effect of altitude on total particle count.

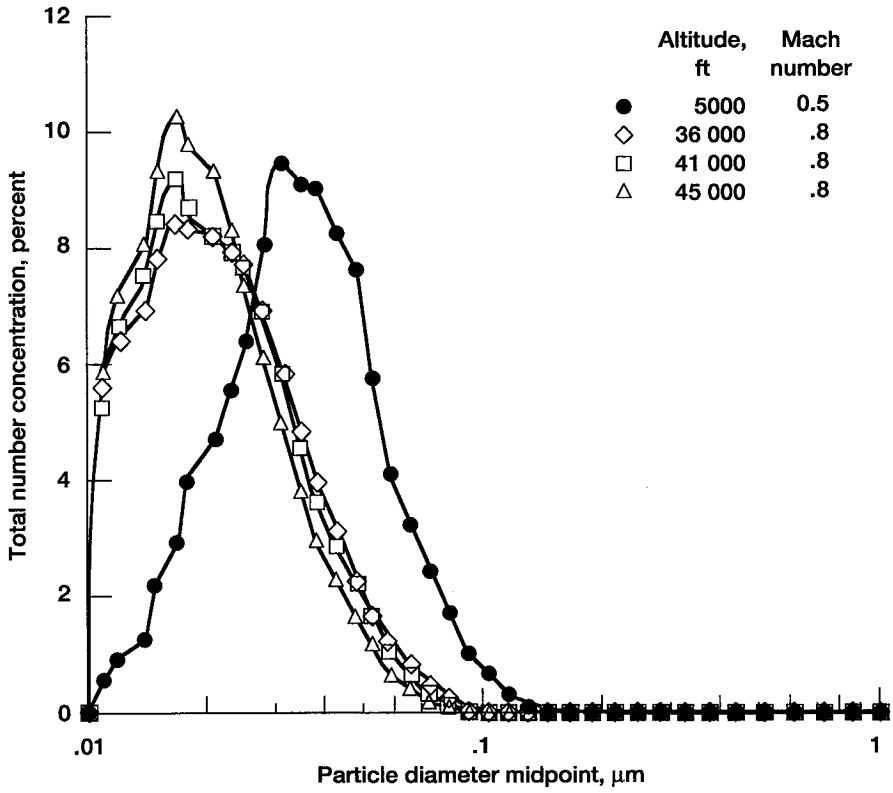


Figure 10.—Effect of altitude on particle distribution at 95-percent engine speed.

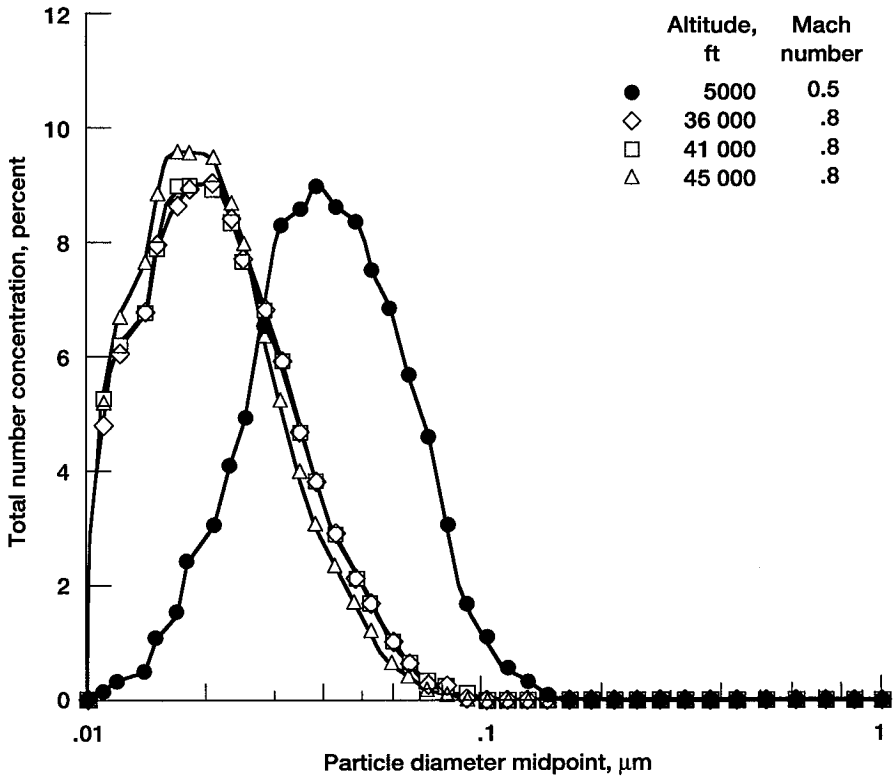


Figure 11.—Effect of altitude on particle distribution at 97.5-percent engine speed.

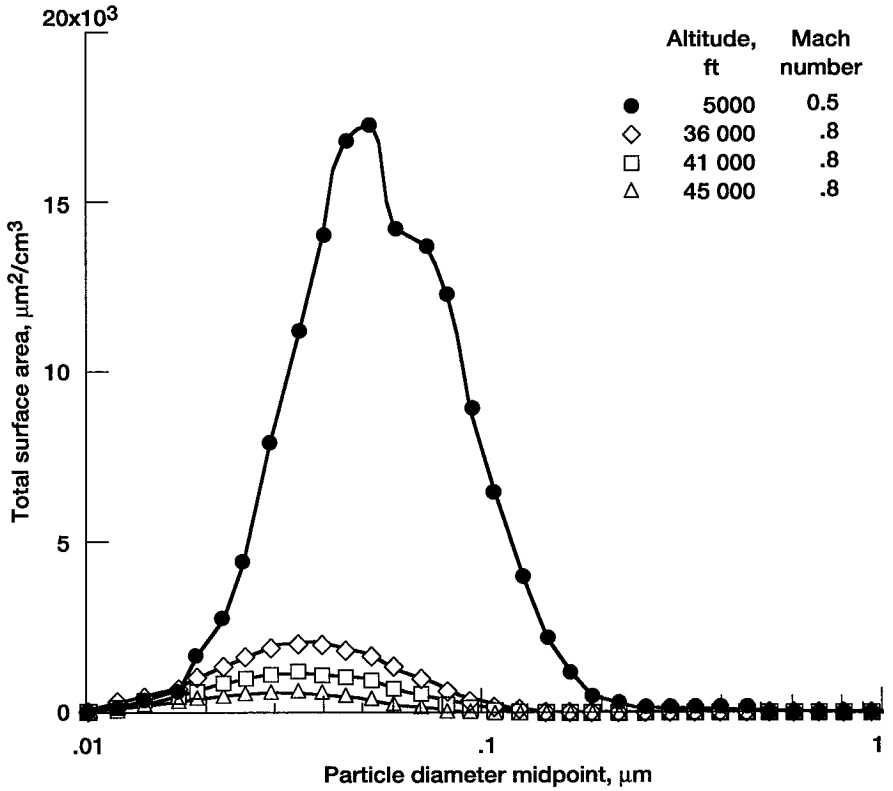


Figure 12.—Effect of altitude on total surface area at 95-percent engine speed.

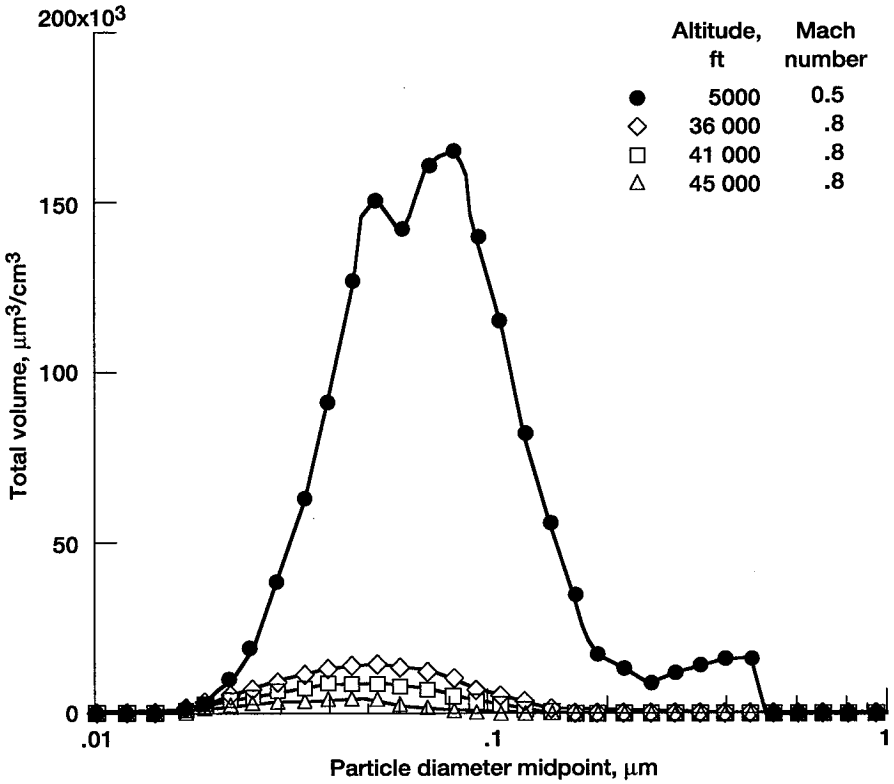


Figure 13.—Effect of altitude on total volume at 95-percent engine speed.

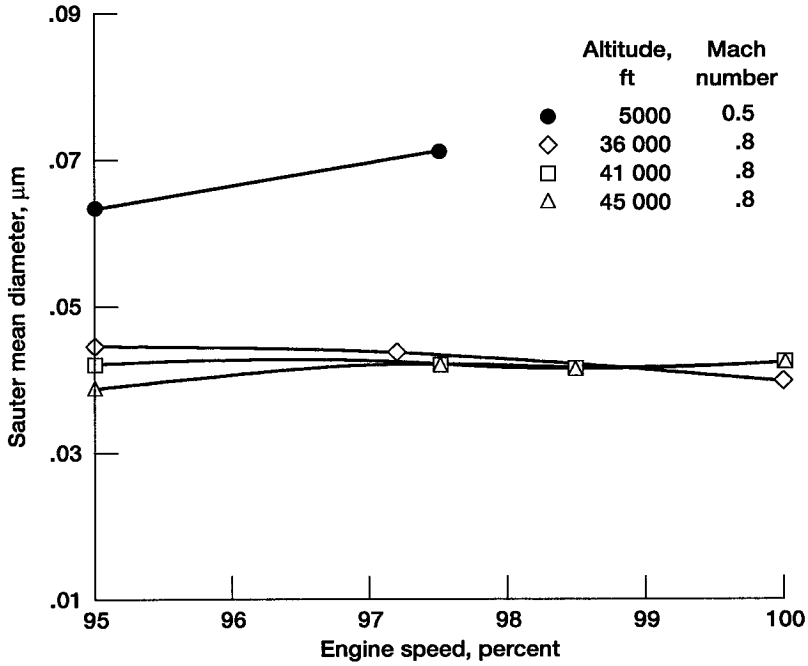


Figure 14.—Effect of altitude on Sauter mean diameter.

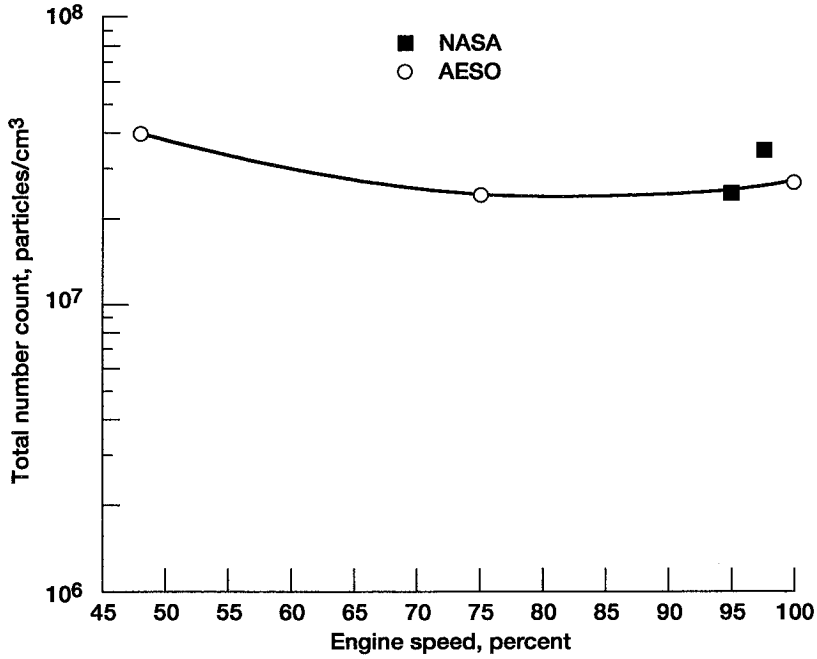


Figure 15.—Comparison of NASA and AESO total particle count (AESO conditions: sea-level, Mach 0; NASA conditions: 5000 ft, Mach 0.5).

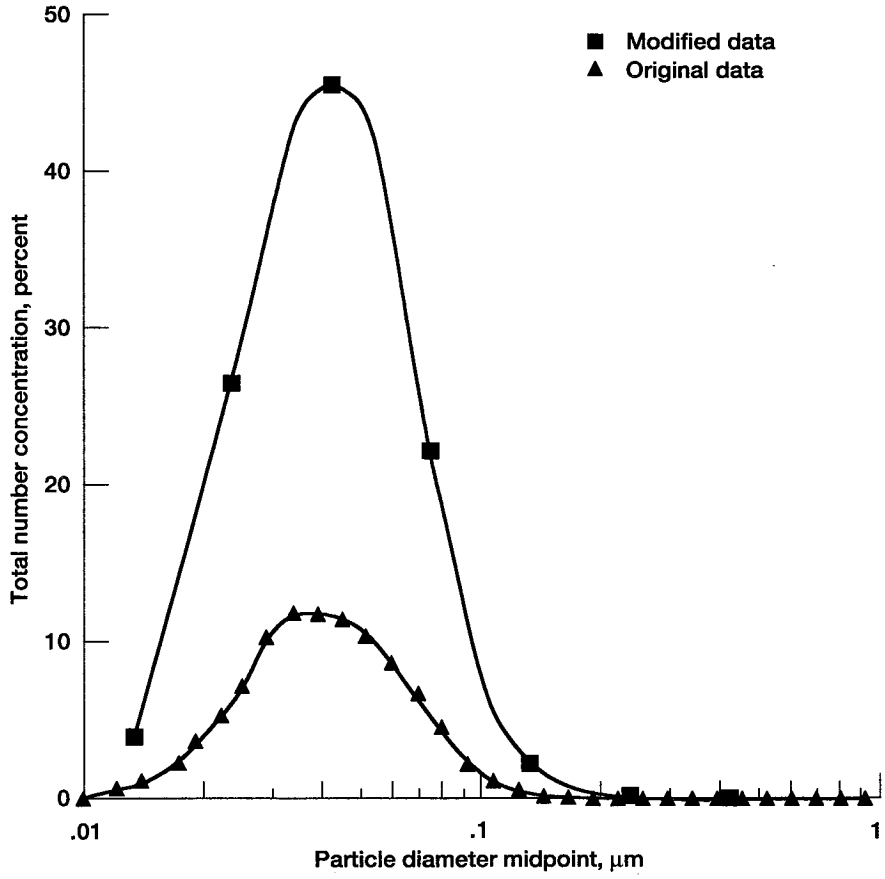


Figure 16.—Modification of NASA particle data.

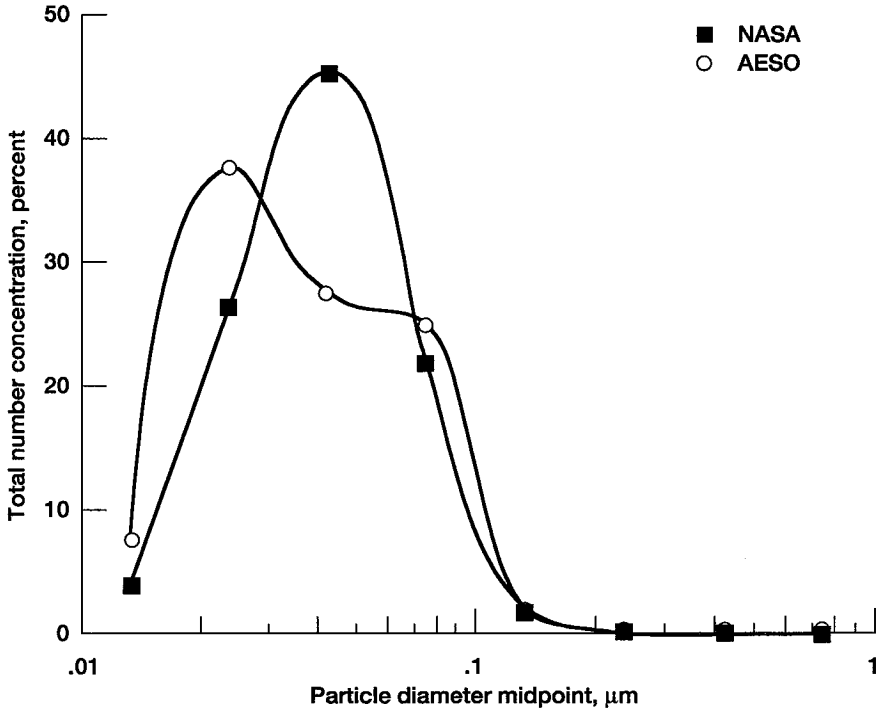


Figure 17.—Comparison of NASA and AESO particle count distribution (AESO conditions: sea-level, Mach 0, 100-percent speed; NASA conditions: 5000 ft, Mach 0.5, 97.5-percent speed).

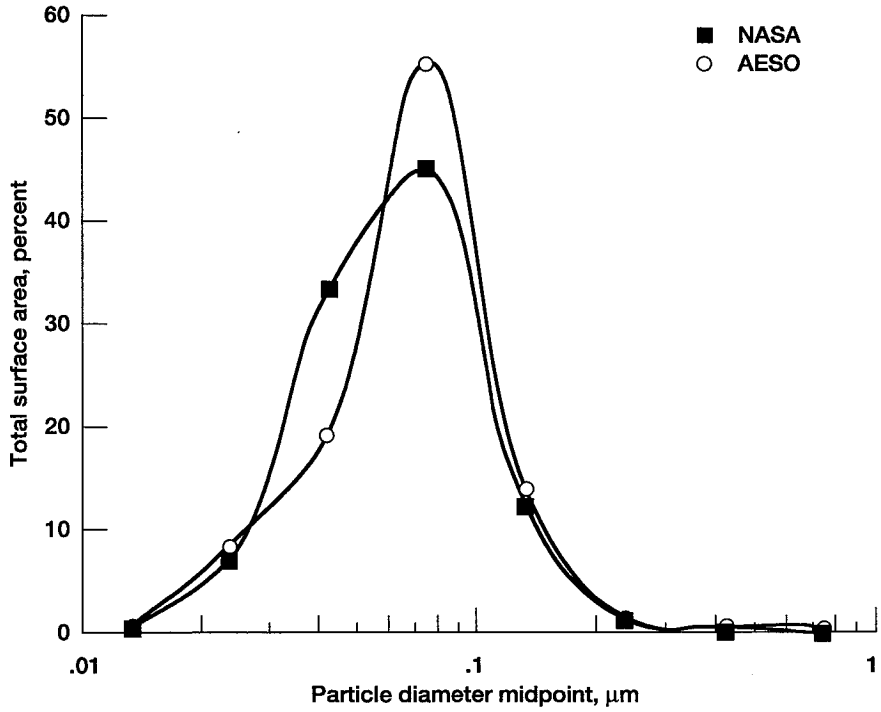


Figure 18.—Comparison of NASA and AESO percent of total surface area (AESO conditions: sea-level, Mach 0, 100-percent speed; NASA conditions: 5000 ft, Mach 0.5, 97.5-percent speed).

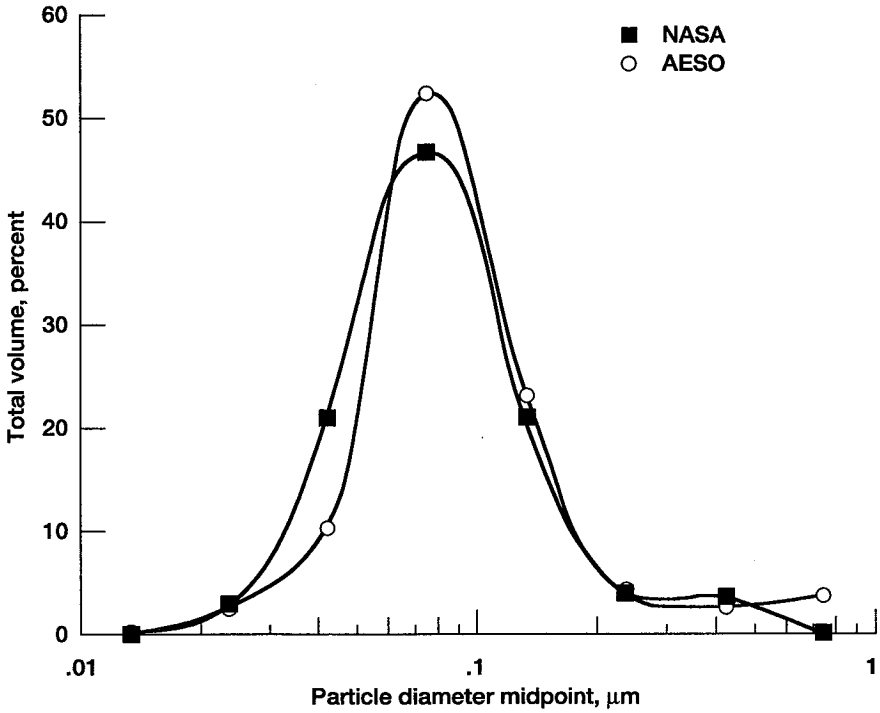


Figure 19.—Comparison of NASA and AESO percent of total volume data (AESO conditions: sea-level, Mach 0, 100-percent speed; NASA conditions: 5000 ft, Mach 0.5, 97.5-percent speed).

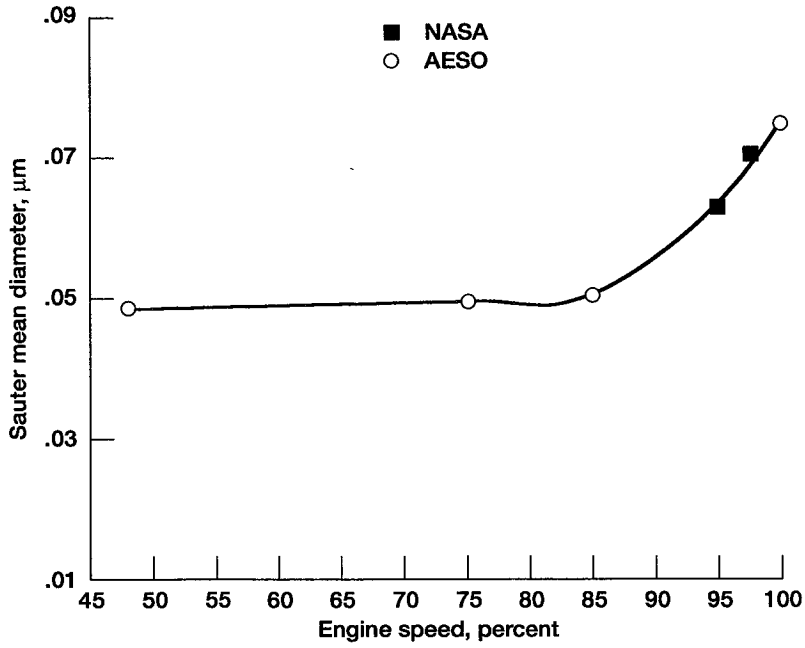


Figure 20.—Comparison of NASA and AESO Sauter mean diameter (AESO conditions: sea-level, Mach 0; NASA conditions: 5000 ft, Mach 0.5).

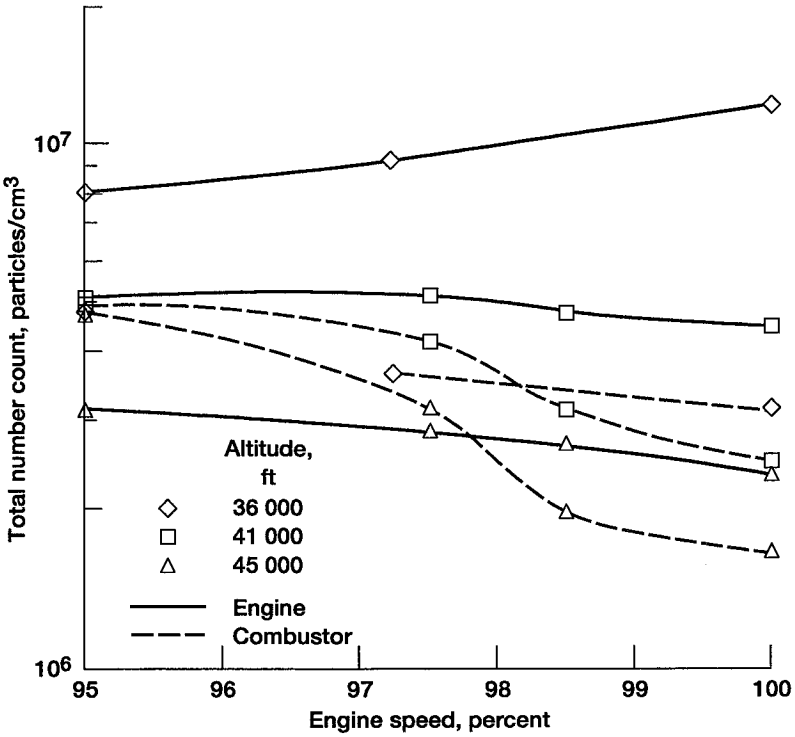


Figure 21.—Comparison of engine and combustor total number count at various altitudes.

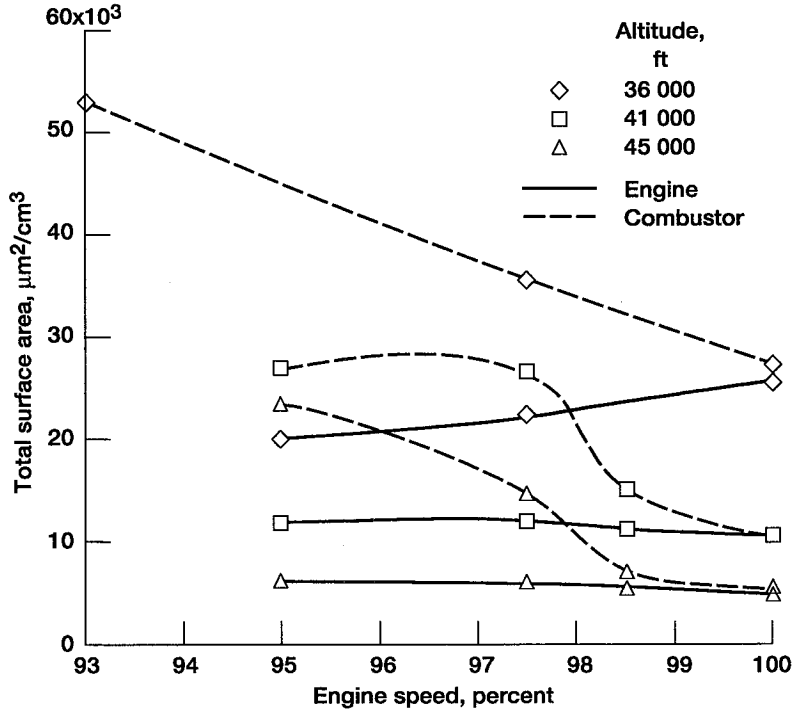


Figure 22.—Comparison of engine and combustor total surface area at various altitudes.

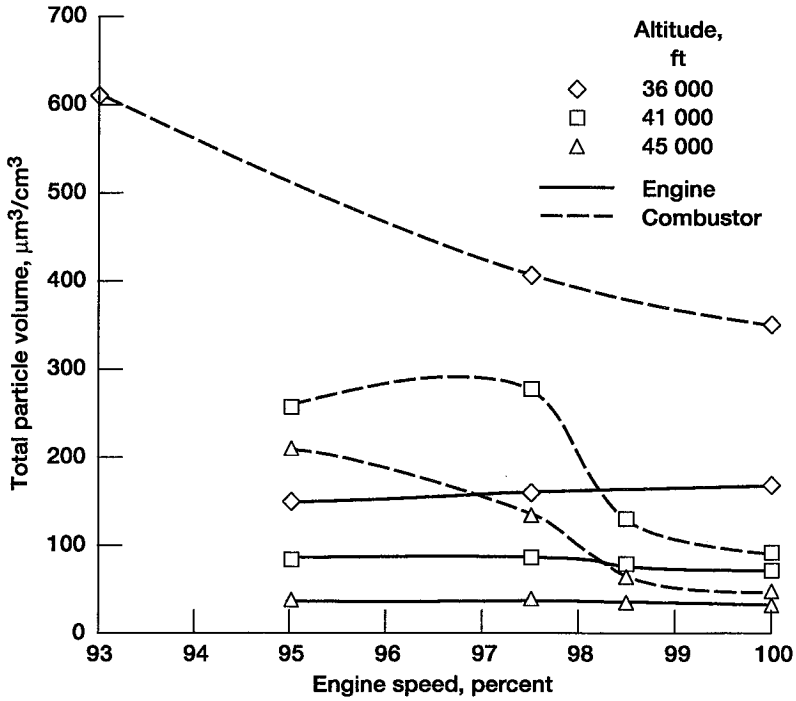


Figure 23.—Comparison of engine and combustor particle volume data at various altitudes.

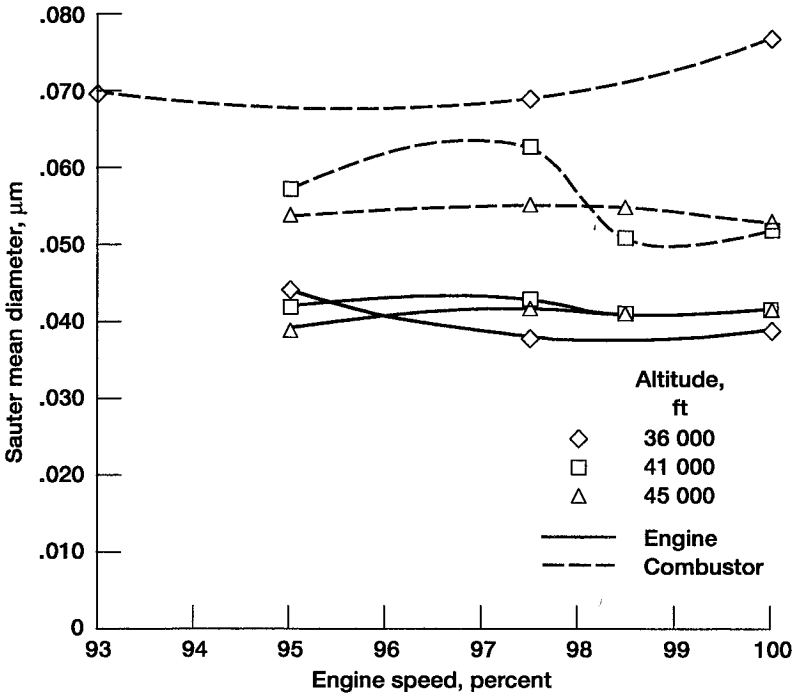


Figure 24.—Comparison of engine and combustor particle data at various altitudes.

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13. ABSTRACT (*Maximum 200 words*)

Particles from a J85-GE-5L turbojet engine were measured over a range of engine speeds at simulated altitude conditions ranging from near sea level to 45 000 ft and at flight Mach numbers of 0.5 and 0.8. Samples were collected from the engine by using a specially designed probe positioned several inches behind the exhaust nozzle. A differential mobility particle sizing system was used to determine particle size. Particle data measured at near sea-level conditions were compared with Navy Aircraft Environmental Support Office (AESO) particle data taken from a GE-J85-4A engine at a sea-level static condition. Particle data from the J85 engine were also compared with particle data from a J85 combustor at three differenct simulated altitudes.

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